Final Report

Life Cycle Assessment of *AERA* Footwear

Prepared for:

The Humble Shoe Company, Inc.

May 28, 2019

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1. General Objective and Description of the Investigated Systems

This report presents the findings of the Life Cycle Assessment (LCA) conducted by SCS Global Services (SCS) of *The Humble Shoe Company, Inc.'s AERA* footwear products produced in the Veneto region of Italy. The study is conducted in conformance with the requirements of ISO 14040 and ISO 14044 for LCA, and considers the potential environmental impacts associated with the manufacture and distribution of the products to consumer markets in the United States. The study is conducted in order to quantify the environmental impacts of *AERA* shoes over the product life cycle and to facilitate *The Humble Shoe Company, Inc.'s* efforts to fulfill their commitment to sustainability, and offset 110% of the products environmental impacts.

LCA addresses the environmental aspects and potential environmental impacts throughout a product's life cycle. Twelve (12) styles of the *AERA* fashion footwear product line, available in with various outer materials encompassing 45 unique products, are included in the LCA study and described in Table 1.

Table 1. *AERA* footwear products included in the LCA study.

Product Style	Available Outer styles for the product style	Average Weight (grams/pair)	Manufacturing Location
The Platform	Ctd. Bomber Piton Crom Platino; Tessuto Notturno	480	VP Shoes
The 95 Pump	Ctd. Patchsnake Ss; Premiere Must Lux 100 Cammeo; Ctd. Tender Ac-Drill Nero; Ctd. Grand Pythonss; Tessuto Notturno	290	VP Shoes
The Mule	Ctd. Tender Ac-Drill Navy; Ctd. Tender Ac-Drill Nero; Ctd. Grand Pythonss	350	VP Shoes
The 95 Slingback	Ctd. Patchsnake Ss; Ctd. Bomber Piton Crom Platino; Ctd. Tender Ac-Drill Nero; Tessuto Notturno	260	VP Shoes
The 75 Slingback	Ctd. Patchsnake Ss; Premiere Must Lux 100 Cammeo; Premiere Must Lux 100 Hortensia; Premiere Must Lux 100 Nera; Premiere Must Lux 100 Bianco; Ctd Specchio Crom Extra 85 Argento 1; Ctd Specchio Crom Extra 85 Jute; Ctd. Grand Pythonss	270	VP Shoes
Ballerina	Ctd. Bomber Piton Crom Argento; Ctd. Bomber Piton Crom Platino; Ctd. Grand Pythonss	230	VP Shoes
Slingback Flat	Ctd. Patchsnake Ss; Premiere Must Lux 100 Cammeo; Premiere Must Lux 100 Hortensia; Premiere Must Lux 100 Nera	260	VP Shoes
The Slipper	Premiere Must Lux 100 Nera; Ctd. Tender Ac-Drill Nero; Ctd. Grand Pythonss; Tessuto Notturno	350	New Empire
The Loafer	Ctd. Tender Ac-Drill Navy; Ctd. Tender Ac-Drill Beige	340	New Empire
The Derby	Premiere Must Lux 100 Nera; Premiere Must Vitello 85	370	New Empire
The Ankle Boot	Premiere Must Lux 100 Nera; Ctd. Tender Ac-Drill Navy; Ctd. Tender Ac-Drill Beige; Ctd. Grand Pythonss; Premiere Must Vitello 85	560	New Empire
The Rockerboot	Tessuto Notturno; Ctd. Grand Pythonss; Premiere Must Vitello 85	550	New Empire

The goals of the study include three primary objectives:

1. To assess the potential environmental impacts associated with the manufacture and distribution of the *AERA* footwear following the guidance and requirements of ISO 14044[1]; and,
2. To quantify the carbon footprint of the *AERA* footwear, over the product life cycle, including raw material extraction and processing, product manufacture, packaging, and product distribution, with the goal of offsetting up to 110% of the greenhouse gas emissions from manufacture and distribution of the product.
3. To quantify other potential environmental impacts, in addition to the impact from greenhouse gases, from the manufacture and distribution of the *AERA* footwear, with the goal of offsetting up to 110% of the environmental impacts of the product.

Life Cycle Impact Assessment (LCIA) results are reported using the indicators based on the TRACI 2.1[2] and CML-IA[3] characterization methodologies.

The LCA study scope, methodology, data sources, assumptions, and limitations used to calculate indicator results developed for the study are described in this report. The following life cycle stages are included: raw material extraction and processing; transport to manufacturer; product manufacturing; and packaging; and product distribution.

This report is provided to aid in understanding the life cycle impacts and potential benefits of the *AERA* footwear products. The intended audience for this LCA report includes *The Humble Shoe Company* and other stakeholders. This report will be critically reviewed by an LCA practitioner independent of the project for conformance to ISO 14044.

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[1] ISO 14044:2006 Environmental management – Life Cycle Assessment – Requirements and guidelines
[2] Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Dr. Bare, J., http://www.epa.gov/nrmrl/std/traci/traci.html.
[3] CML 4.1 baseline, from Institute of Environmental Sciences Faculty of Science University of Leiden, Netherlands.

2. Study Parameters

2.1 Goal and Scope of the Assessment

The LCA scope of this study is "cradle-to-gate" plus product distribution, including raw material extraction, processing of raw materials, product manufacture and packaging; and product distribution. Impacts associated with the transport of returned products are also included, based on an expected return rate estimated by the manufacturer. Resource consumption, emissions and wastes and their associated potential environmental impacts are calculated for the *AERA* footwear products manufactured at the *VP Shoes* and *New Empire Luxury Brand* facilities in Galta di Vigonovo and Peraga di Vigonza, Italy, respectively. The life cycle stages modules included in the study are described in Table 2.

Table 2. The modules and unit processes included in the scope for the *AERA* footwear.

Module	Module description	Unit Processes Included in Scope
Raw Materials Processing (Sourcing/Extraction) stage	Extraction and processing of raw materials; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the footwear product components.
Transport stage	Transport (to the manufacturer)	Transport of component materials to the manufacturing facilities
Manufacturing stage	Manufacturing, including ancillary material production	Manufacturing of AERA footwear (incl. upstream unit processes*)
Packaging stage	Extraction and processing of packaging materials and transport to manufacturer	Extraction and processing of packaging materials; transport to manufacturer
Product Distribution	Transport (product distribution; product returns)	Transport of product (including packaging) to consumer; transport of returned product

**This includes unit processes involved in the generation of electricity.*

2.2 Functions of the Product System and the Functional Unit

The *AERA* footwear products provide the primary function of covering or protecting the foot. According to ISO 14044, the functional unit is "the quantified performance of a product system, for use as a reference unit." The functional unit, and reference flow, used in the study, is one pair of shoes of a specified mass, consistent with ISO requirements. The mass of each pair of shoes assessed (the reference flow) is summarized in Table 1 and Section 2.12.

Example images of the *AERA* footwear products included in the LCA are shown in Figure 1.

Figure 1. Example product images for the *AERA* footwear products: The Slingback Flat **(left)** and The Pump 95 **(right).**

2.3 System Boundary

The product system under study includes the production of all the components shown in Table 7 and Table 8 (Section 2.12), as well as transportation of raw materials, transportation to consumer, and transport of returned product. The system boundaries include all unit processes contributing measurably to category indicator results for those category indicators considered in the assessment. A flow diagram of the product system, including system boundaries, is provided in Figure 2. In the present study, except where noted above, all known materials and processes were included in the life cycle inventory.

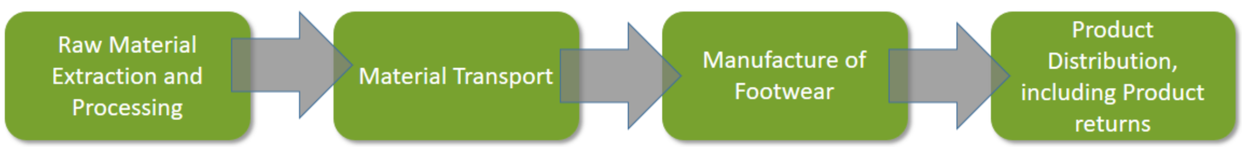

Figure 2. Flow diagram and system boundaries for the production and distribution of the *AERA* footwear.

2.4 The Product System under Study

The *AERA* footwear products are manufactured at two facilities in the Veneto region of Italy. The primary component materials are synthetic and cotton fabrics, rubber, mixed clay and various additives (plasticizers, pigments, and fasteners). The shoes are hand-crafted at the *VP Shoes* and *New Empire* facilities, and packaged in cotton fabric bags and recycled cardboard boxes.

The LCA scope of this study is "cradle-to-delivered product", including raw material extraction, processing of raw materials, product manufacture, packaging and product distribution. Impacts associated with the transport of returned products are also included. The manufacturer estimates a product return rate of approximately 30%. The electricity supply mix for the VP Shoes and New Empire facilities is modeled using a modified ecoinvent dataset for the grid mix in Italy[4,5]. Product packaging is also included in the model and consists of cotton fabric bags, paper, and cardboard boxes.

Transportation of the finished product to the point of use was modeled using average transport distances, and estimated product return rates, based on data provided by *The Humble Shoe Company* (Section 2.13).

2.5 Allocation Procedures

This study follows the allocation guidelines of ISO 14044, and sought to minimize the use of allocation wherever possible. According to the ISO, allocation procedures should be based on physical relationships (e.g., volume, energy content, or mass-based relationships). As an alternative, economic allocation may be used. The secondary databases used for the product system (discussed below) apply allocation based primarily on physical relationships.

Annual facility-level electricity use data were provided by the manufacturers' facilities for calendar year 2018. Resource use was allocated to the products based on the mass of the product as a fraction of the total facility production volume using the data provided. Impacts from transportation were allocated based on the mass of material and distance transported.

The *AERA* footwear product system contains some recycled materials which are allocated using the recycled content allocation method (also known as the 100-0 cut off method). Using the recycled content allocation approach, system inputs with recycled content do not receive any burden from the previous life cycle other than reprocessing of the waste material. At end-of-life, materials which are recycled leave the system boundaries with no additional burden.

2.6 LCIA Methodology and Interpretation Used

The LCIA conforms to ISO 14040 and ISO 14044. LCIA methodologies are used to relate the LCI results to the associated environmental impacts, where the LCI results are classified within impact categories, each with a category indicator. The choice of methods and indicators used in the assessment are based on the requirements of ISO 14044. It should be noted that the LCIA results presented below are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Additionally, the environmental relevance of LCIA results is not affected by LCI functional unit calculation, system wide averaging, aggregation and allocation.

Within LCIA, two approaches of characterization may occur along the environmental pathway of an impact indicator: midpoint approach and endpoint approach. Characterization at the midpoint level

[4] http://www.optimaitalia.com/public/files/pdf/energia-elettrica-e-gas-naturale/elettricit%C3%A0/Composizione_del_Mix_Medio_Nazionale_utilizzato_per_la_produzione_di_energia_elettrica.pdf
[5] https://www.servizioelettriconazionale.it/it-IT/mixmedio_combustibili

models the impact using an indicator located somewhere along the environmental mechanism prior to the endpoint damage categories; while characterization at the endpoint level requires modeling through to the endpoint categories described by the areas of protection (primarily ecosystem quality, human health and resources). In addition to differences according to environmental modeling approach (midpoint and endpoint), other differences among LCIA methodologies include the number of impact categories, and substances, covered by each methodology, as well as temporal and geographic variations in characterization data used. In the current study, impact category indicators are estimated using the TRACI 2.1[6] and CML-IA[7] characterization methodologies.

TRACI (Tool for the Reduction and Assessment of Chemical and other environmental Impacts) is a midpoint oriented methodology developed by the US Environmental Protection Agency (US EPA), with aim of assisting in the impact assessment of process designs and achieving pollution prevention. The midpoint impact categories considered in the methodology include: Ozone depletion, global warming, smog formation, acidification, eutrophication, human health cancer, human health non cancer, human health criteria pollutants, eco-toxicity, and fossil fuel depletion. The impact categories were selected and characterized based on the data and information from the U.S. EPA. The normalization factors are based on annual emissions and resources for the US. No weighting method is embedded in the methodology. The regional validity for the methodology is appropriate to US, although global impact categories, such as ozone layer depletion and global warming, are also considered.

The CML-IA is a midpoint method first developed in 1992 by the Institute of Environmental Sciences of the University of Leiden (CML). The CML method groups the impact categories into two groups: Obligatory impact categories (baseline impact categories) which are the impact categories used in most LCA studies, and additional, optional impact categories which are typically study dependent. The base line impact categories considered in the methodology include: Depletion of abiotic resources, land competition, climate change, stratospheric ozone depletion, human toxicity, freshwater aquatic ecotoxicity, marine aquatic ecotoxicity, terrestrial ecotoxicity, photo-oxidant formation, acidification and eutrophication. Characterization is based on global and European average values while normalization is based on global normalization factors. No weighting method is embedded in the methodology. The regional validity of the CML methodology impact categories is global, except for acidification and photo-oxidant formation, which are based on average European values.

The impact indicators considered for the assessment include:

- Potential for Global Warming,
- Acidification Potential,
- Eutrophication Potential,
- Photochemical Ozone (Smog) Creation Potential,

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[6] Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Dr. Bare, J., http://www.epa.gov/nrmrl/std/traci/traci.html
[7] CML-IA Characterization Factors. Leiden University, Institute of Environmental Sciences. April 2013. http://cml.leiden.edu/software/data-cmlia.html

- Ozone Depletion Potential,
- Fossil Fuel Depletion Potential[8],
- Abiotic Resource Depletion Potential (elements)[9], and
- Abiotic Resource Depletion Potential (fossil fuels)[10].

Note that for global warming calculations, the CML characterization factors are based on IPCC 2013, while TRACI 2.1 global warming calculations are based on IPCC 2007. Note also that neither characterization method includes biogenic carbon uptake or biomass CO_2 emissions. The impact category indicators included in the assessment are summarized below.

Category Indicator	Units	Impact Category and Environmental Mechanism
Global Warming Potential of GHGs over 100 years (GWP)	kg CO_2 eq.	Anthropogenic emissions of greenhouse gases and short-lived climate forcers have led to increased radiative forcing, which has in turn increased the global mean temperature by 0.8°C since pre-industrial times. This is projected to increase to 1.5°C by 2035, 2.0°C by 2050, and 4.0°C by 2100. As global mean temperatures continue to climb, global climate change will result. Some of the predicted impacts include reductions in food and food supplies, water supplies, and sea level rise.[11]
Ozone Layer Depletion (ODP Steady State) (ODP)	kg CFC-11 eq.	Emissions of ozone depleting substances such as chlorofluorocarbons contribute to a thinning of the stratospheric ozone layer. This can lead to increased cases of skin cancer, and effects on crops, other plants, marine life, and human-built materials. All chlorinated and brominated compounds stable enough to reach the stratosphere can have an effect. CFCs, halons and HCFCs are the major causes of ozone depletion. Damage to the ozone layer reduces its ability to prevent ultraviolet (UV) light entering the earth's atmosphere, increasing the amount of carcinogenic UVB light reaching the earth's surface. Due to the international ban on ozone depleting chemicals, the stratospheric ozone layer has begun to recover; U.S. EPA projects that the ozone layer will recover within about 50 years.
Photochemical Oxidant Creation Potential (POCP)	kg C_2H_4 eq – CML kg O_3 eq - TRACI	Photochemical ozone, also called "ground level ozone", is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. If ozone concentrations reach above certain critical thresholds, health effects in humans can result, including bronchitis, asthma, and emphysema. The impact category depends largely on the amounts of carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds).
Acidification (AP)	kg SO_2 eq	Acidification is the increasing concentration of hydrogen ion (H^+) within the local environmental and occurs as a result of adding acids such as nitric acid and sulphuric acids into the environment. Acid precursor emissions transport in the atmosphere and deposit as acids. These acids may deposit in soils which are sensitive, or insensitive, to the increased acid burden; sensitivity can depend on a number of factors. In acid-sensitive soils, the deposition can decrease the soil pH (acidification) and increase the mobility of heavy metals in the environment, such as aluminum. This acidification can affect the pH of local soils and freshwater bodies, by increasing local hydrogen ion concentrations, causing endpoints such as tree die-offs and dead lakes. Emissions of sulphur dioxide and nitrogen oxides from the combustion of fossil fuels have been the greatest contributor to acid rain.

[8] TRACI 2.1 only
[9] CML-IA only
[10] Ibid.
[11] Stocker, T.F., et al. 2013: Technical Summary. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Category Indicator	Units	Impact Category and Environmental Mechanism
Eutrophication (EP)	kg PO_4^{3-} eq – CML kg N eq - TRACI	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. In some regions, emissions of excess nutrients (including phosphorus and nitrogen) into water can lead to increased algal blooms. These blooms can reach such a severity that waterways become choked, with no other plant life able to establish itself. If algal blooms are intense enough, the decaying algae consumes dissolved oxygen in the water column starving other organisms of needed oxygen. Whereas phosphorous is mainly responsible for eutrophication in freshwater systems, nitrogen is mainly responsible for eutrophication in ocean water bodies. Emissions of ammonia, nitrates, nitrogen oxides and phosphorous to air or water all have an impact on eutrophication.
Fossil Fuel Depletion (FFD)	MJ surplus	This impact category reflects the relative abundance and depletion of feedstock reserves resulting from the net consumption of fossil energy resources used for electric power generation, operations and transport, and for incorporation into materials such as plastics. This indicator takes into account the amount of resources used for the function under study, the availability of economically recoverable reserves, the degree to which such resources may be replenished, the relative efficiency of power generation systems and fuel systems, and whether the resource is available for reuse at end of life (e.g., recycling). All fossil fuel resources which are consumed in a non-renewable fashion are included.
Abiotic Depletion (elements) (ADPE)	kg Sb eq	This impact category refers to the consumption of non-biological resources such as minerals and metals. The value of the abiotic resource consumption of a substance is a measure of the scarcity of a substance and depends on the amount of resources and the extraction rate. The indicator is calculated as the amount of resources that are depleted and measured in antimony equivalents for mineral depletion.
Abiotic Depletion (fossil fuels) (ADPF)	MJ eq	This impact category refers to the consumption of fossil fuels. The value of the abiotic resource consumption of a substance (e.g., lignite or coal) is a measure of the scarcity of a substance and depends on the amount of resources and the extraction rate. It is calculated as the amount of resources that are depleted and measured in equivalent MJ of fossil fuels.

Although not required, primary energy demand, water consumption and waste flows are also included as part of the assessment. These additional parameters were assessed using the following methods, consistent with international guidance[12] and standards[13]:

- *Primary Energy Demand (PED).* This parameter is the total consumption of primary energy resources for the product system.
- *Total use of renewable primary energy resources (PERT).* This parameter is the total consumption of renewable primary energy resources for the product system.
- *Total use of non-renewable primary energy resources (PENRT).* This parameter is the total consumption of non-renewable primary energy resources for the product system.
- *Net use of fresh water (FW).* Net use of fresh water is included in the Ecoinvent datasets used for the modeling and are reported, in m^3, for all modules.

[12] Product Category Rules According to ISO 14025:2006. Product Group Classification: UN CPC 293, 295 Professional Footwear. Version 1.01. International EPD® System. November 2014.
[13] ISO 21930:2017. Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services

- *Hazardous waste disposed (HWD).* All flows of hazardous waste included in the full LCI and other data sources were aggregated into a single result for total hazardous waste disposal and reported in kg. The parameter is calculated using the method for "Hazardous waste" classification from the EDIP/UMIP 1997 LCIA methodology. The flows which are aggregated, on a mass basis, are shown in Table 3.

Table 3. The flows of hazardous waste aggregated into the result for the parameter of "hazardous waste disposed".

Flow Name	Flow Name
Volume occupied, underground deposit	Oil separator sludge
Asbestos	Oil waste
Bilge oil	Refinery sludge
Chemical waste, inert	Waste, from incinerator
Chemical waste, regulated	Waste, toxic
Chemical waste, unspecified	Welding dust
Electrostatic filter dust	

- *Non-hazardous waste disposed (NHWD).* This includes all wastes produced across all life cycle stages included in the study scope. The parameter is calculated using the method for "Bulk waste" classification from the EDIP/UMIP 1997 LCIA methodology. Flows of non-hazardous waste included in the full LCI were also aggregated into a single result for total non-hazardous waste disposal and reported in kg.

All results are calculated with the SimaPro 8.3 model using primary and secondary inventory data as described below.

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment[14]. The interpretation included the use of evaluation and sensitivity checks to steer the iterative process during the assessment, and a final evaluation including completeness, sensitivity, and consistency checks, at the end of the study.

2.7 Data Requirements

This study included several key data requirements:

- Functional description of the products,
- Material composition of the *AERA footwear* products and packaging,
- Primary data for the *VP Shoes* and *New Empire* operations, including energy use, emissions, and waste generation,

[14] European Joint Research Commission. International Reference Life Cycle Data System handbook. *General guide for Life Cycle Assessment – Detailed Guidance.* © European Union, 2010.

- Representative inventory data for many unit processes, using secondary data from the Ecoinvent[15] life cycle databases, with a prioritization for data with the highest degree of representativeness of the actual material or process, and
- Transportation data for materials and estimates of product distribution.

2.8 Value Choices and Optional Elements

The study avoids the use of value choices in the assessment, as described in ISO 14044, such as normalization, weighting or grouping of indicator results. The study includes a data quality assessment, considered optional under ISO 14044.

2.9 Study Limitations

As a result of the choice of study scope and LCIA methodologies used, there were several important study limitations which should be understood to ensure an appropriate interpretation of results. None of these limitations were judged to have significant relevance to final indicator results, and were deemed acceptable limitations. A description of the assumptions leading to the key study limitations is provided in Section 3.

Limitations in the Study Scope

- Energy use (electricity) was reported for the manufacturing facilities and allocated to the product based on the mass of the product as a fraction of the total facility production (i.e., mass-based allocation).
- Specific LCI data to model many of the product components were not available. Existing ecoinvent datasets were reviewed for applicability and used as appropriate to represent the material composition of each material based on information provided by the manufacturer.

Limitations in Life Cycle Impact Assessment Phase

There are several important limitations in the LCIA methodologies used. These limitations are described below.

There may be additional impacts relevant to the production of the *AERA* footwear products at the manufacturing facilities. Some of these omitted impact categories are listed in Table 4. This list is not exhaustive; there may be other impact categories which are not included.

[15] Ecoinvent v3.3. 2016. Swiss Center for Life Cycle Inventories, 2017. http://www.ecoinvent.org

Table 4. Impact categories omitted from the LCA.

Impact Categories	Impact Categories
Terrestrial Biome Disturbance	Hazardous Environmental Contaminant Exposure Risks
Freshwater Biome Disturbance	$PM_{2.5}$ Exposures
Wetland Biome Disturbance	Hazardous Ambient Air Contaminant Exposure Risks
Loss of Key Species	Hazardous Food and Water Contaminant Exposure Risks
Arctic Climate Change	Risks from Radioactive Wastes
Ocean Acidification	

It should also be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Limitations in Results for Other Parameters

The assessment included results for several inventory flows including primary energy demand, water use and hazardous and non-hazardous wastes. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted taking into account this limitation.

2.10 Data Quality Requirements

One of the primary goals of the study is to assess the potential impact reductions associated with the manufacture of *AERA* footwear products; the overarching data quality requirements are to enable a reliable assessment of the indicator results for all reported impact categories, with data quality sufficient as to identify the key unit processes, differentiated by overall contribution to final results.

No data gaps were allowed which were expected to significantly affect the outcome of the indicator results.

2.11 Type of Critical Review

This LCA report will be critically reviewed by an internal and independent LCA expert not involved with the execution of this study, in conformance with ISO 14044.

2.12 Product Composition

The product system studied in this LCA includes the "cradle-to-product delivered" impacts of *AERA* footwear described above and shown in Figure 1. The reference flow for each product system is defined as one (1) pair of shoes of a specified mass. Although style options may vary across the products assessed, all are composed of similar materials from common suppliers. Table 5 and Table 6 summarize the components by weight and material for the product, including product packaging. Also presented are the product components as a percent of total mass.

Table 5. Material component summary for the *AERA* footwear products by mass in grams (per 1 pair) and as a percentage of total mass. (VP Shoes production)

Component	Composition	*The Platform*	*The 95 Pump*	*The Mule*	*The 95 Slingback*	*The 75 Slingback*	*Ballerina*	*Slingback Flat*
PRODUCT								
Outer	Cotton-poly textile	87.0 18%	66.4 23%	104 30%	45.8 18%	62.9 23%	66.0 29%	71.0 27%
Lining	Viscose/polyurethane textile	36.0 7.5%	50.0 18%	84.0 24%	25.0 9.7%	25.0 9.2%	63.0 28%	39.0 15%
Sole	Synthetic rubber, Inorganic mineral composts, Additives (pigments, plasticizers)	56.0 12%	46.0 16%	40.0 11%	46.0 18%	46.0 17%	65.0 29%	49.0 19%
Glue	Synthetic latex based	5.00 1.0%	5.00 1.8%	5.00 1.4%	5.00 1.9%	5.00 1.8%	5.00 2.2%	5.00 1.9%
Heel	Wood ; Expanded Ethylene-vinyl acetate	195 41%	- -	- -	- -	- -	- -	- -
	Recycled ABS plastic; Steel Rod	- -	25.0 8.8%	- -	25.0 9.7%	20.0 7.4%	- -	- -
	Recycled ABS plastic	- -	- -	38.0 11%	- -	- -	- -	- -
	Thermoplastic polyurethane	- -	- -	- -	- -	- -	6.00 2.6%	- -
	Wood, Thermoplastic polyurethane	- -	- -	- -	- -	- -	- -	15.0 5.7%
Toplift	Thermoplastic polyurethane	7.00 1.5%	1.00 0.35%	1.00 0.28%	1.00 0.39%	1.00 0.37%	- -	3.75 1.4%
Insole	Cellulose (20% recycled content); Stainless steel	64.0 13%	65.0 23%	63.0 18%	78.0 30%	80.0 29%	- -	52.0 20%
Under-Lining Padding	PVC	10.0 2.1%	- -	- -	10.0 3.9%	10.0 3.7%	- -	- -
Counterback	Cotton; Polychloroprene; Polycaprolactone	- -	10.0 3.5%	- -	- -	- -	- -	- -
Point	Cotton; Polychloroprene	- -	5.00 1.8%	5.00 1.4%	- -	- -	- -	5.00 1.9%
Top-Line Tape	Cotton	7.00 1.5%	7.00 2.5%	7.00 2.0%	7.00 2.7%	7.00 2.6%	7.00 3.1%	7.00 2.7%
Buckle	Zamak	5.00 1.0%	- -	- -	- -	- -	- -	- -
Thread	Polyester	5.00 1.0%	5.00 1.8%	5.00 1.4%	5.00 1.9%	5.00 1.8%	5.00 2.2%	5.00 1.9%
Elastic	Polyester	- -	- -	- -	10.0 3.9%	10.0 3.7%	10.0 4.4%	10.0 3.8%
Total Product		***477*** ***100%***	***285*** ***100%***	***352*** ***100%***	***258*** ***100%***	***272*** ***100%***	***227*** ***100%***	***262*** ***100%***
PACKAGING								
Box	40% Post-consumer Recycled Waste Paper	611 80%	263 64%	263 64%	263 64%	263 64%	263 64%	263 64%
Paper Padding	Post-consumer Waste Recycled Paper	100 13%	100 24%	100 24%	100 24%	100 24%	100 24%	100 24%
Shoe Bag	Organic Cotton/Waxed cotton drawstring	50.0 6.6%	50.0 12%	50.0 12%	50.0 12%	50.0 12%	50.0 12%	50.0 12%
Total Packaging		***761*** ***100%***	***413*** ***100%***	***413*** ***100%***	***413*** ***100%***	***413*** ***100%***	***413*** ***100%***	***413*** ***100%***

Table 6. Material component summary for the *AERA* footwear products by mass in grams (per 1 pair) and as a percentage of total mass. (New Empire production)

Component	Composition	*The Slipper*	*The Loafer*	*The Derby*	*The Ankle Boot*	*The Rockerboot*
PRODUCT						
Outer	Cotton-poly textile	99.3 28%	89.0 26%	121 33%	212 38%	187 34%
Lining	Viscose/polyurethane textile	63.0 18%	63.0 19%	63.0 17%	126 23%	126 23%
Sole	Synthetic rubber, Inorganic mineral composts, Additives (pigments, plasticizers)	65.0 19%	65.0 19%	65.0 18%	65.0 12%	65.0 12%
Glue	Synthetic latex based	5.00 1.4%	5.00 1.5%	5.00 1.3%	5.00 0.90%	5.00 0.90%
Heel	Wood, Thermoplastic polyurethane	25.0 7.2%	25.0 7.4%	25.0 6.7%	25.0 4.5%	50.0 9.0%
Insole	Cellulose (20% recycled content); Stainless steel	65.0 19%	65.0 19%	65.0 18%	65.0 12%	65.0 12%
Under-Lining Padding	PVC	10.0 2.9%	10.0 2.9%	10.0 2.7%	10.0 1.8%	10.0 1.8%
Point	Cotton; Polychloroprene	5.00 1.4%	5.00 1.5%	5.00 1.3%	5.00 0.90%	5.00 0.90%
Top-Line Tape	Cotton	7.00 2.0%	7.00 2.1%	7.00 1.9%	7.00 1.3%	7.00 1.3%
Thread	Polyester	5.00 1.4%	5.00 1.5%	5.00 1.3%	5.00 0.90%	5.00 0.90%
Zipper	Polyester	- -	- -	- -	10.0 1.8%	10.0 1.8%
Zipper Puller	Zamak	- -	- -	- -	5.00 0.90%	5.00 0.90%
Zipper Tape Puller	Polyester	- -	- -	- -	15.0 2.7%	15.0 2.7%
Total Product		***349*** ***100%***	***339*** ***100%***	***371*** ***100%***	***555*** ***100%***	***555*** ***100%***
PACKAGING						
Box	40% Post-consumer Recycled Waste Paper	414 72%	414 72%	414 72%	611 75%	611 75%
Paper Padding	Post-consumer Waste Recycled Paper	100 17%	100 17%	100 17%	100 12%	100 12%
Shoe Bag	Organic Cotton/Waxed cotton drawstring	58.0 10%	58.0 10%	58.0 10%	100 12%	100 12%
Total Packaging		***572*** ***100%***	***572*** ***100%***	***572*** ***100%***	***811*** ***100%***	***811*** ***100%***

2.13 Transportation and Distribution

Transportation for the LCA model is based on data for transport from the component manufacturer (1st tier supplier) to the manufacturing facilities in Italy. Transportation data for 2nd tier suppliers (material supplier to component manufacturer) are based on data embedded in the representative LCI datasets.

All material components for the *AERA* footwear are delivered to the manufacturing facilities from local (within < ~20 km) and regional (< ~250 km) suppliers. All transport is assumed to be by diesel truck.

Distribution of the products to consumer outlets is included in the model. Two scenarios are considered – distribution via ocean vessel, and distribution via air freight. According to the manufacturer, the products may be shipped from Venice, Italy to New York via ocean vessel ~ 9,020 km[16] (5,600 miles), or via air freight ~6,680 km[17] (4,150 miles). The products are subsequently transported to consumer outlets via diesel truck. Results for both distribution scenarios are presented.

Distribution from the shipping port to consumer outlets is assumed to be approximately 1,760 km (1,094 miles) based on information from the U.S. Bureau of Transportation Statistics[18].

The manufacturer anticipates some products will be returned by the consumer for various reasons. An estimated 30% of the products are returned, for which transport impacts are modeled assuming the same packaging and return transport to the manufacturer's warehouse in New York. . A sensitivity analysis is conducted to evaluate the impact on the assumed product return rate on the LCA results.

[16] https://www.searates.com/services/distances-time/
[17] https://www.airmilescalculator.com/distance/vce-to-lga/
[18] https://www.bts.gov/surveys/commodity-flow-survey/2017-cfs-preliminary-data

3. Life Cycle Modeling and Inventory Analysis

The life cycle inventory (LCI) of each unit process comprises those material and energy inputs, emissions, wastes, and product outputs associated with the operation. Data sources for these inventories include data provided by the manufacturer, as well as data from Ecoinvent life cycle databases.

Environmental flows from the LCI modeling are used to calculate environmental impacts in the Life Cycle Impact Assessment (LCIA) phase, discussed in Section 4. In the present study, except as noted, all known materials and processes were included in the life cycle inventory.

3.1 Assumptions and Data Sources

The assessment relied on a number of assumptions related to material composition, processing and product distribution. The major assumptions used in the assessment are described below.

- The manufacturing facilities are located in Veneto region of Italy. An Ecoinvent inventory dataset was modified to reflect the energy mix for Italy and used to estimate resource use and emissions from electricity use at the manufacturing facility.
- Electricity use at the production facilities was allocated to the footwear products based on product mass utilizing production data for calendar year 2018 provided by the manufacturer.
- Primary data, including material composition, electricity and resource use and emissions and waste generation, for the lining and outer material components of the *AERA* footwear products were provided by the supplier. Ecoinvent datasets were modified to represent these data and used to model the product system.
- Packaging boxes for the product are manufactured with paper made from organic wastes replacing up to 15% of the cellulose from trees, and containing up to 40% recycled fibre from post-consumer waste[19] reducing their product's carbon footprint by 20%. Additionally, the carbon emissions generated by packaging paper products are fully offset through the purchase and retirement of Carbon Credits[20]. Although the carbon offsets cannot be explicitly included in the LCA results for the *AERA* footwear, they will be accounted for in the estimation of carbon offsets required to mitigate the greenhouse gas impact for the *AERA* footwear products.
- Specific LCI data to model the production of many of the remaining component materials were not available. Representative datasets from ecoinvent were used to represent material composition based on information provided by the manufacturer.
- Impacts from distribution of the products are based on delivery to customers in North America and include the impacts associated with the transport of products returned to the manufacturer. According to the manufacturer, an estimated 30% of their products will be returned. It is

[19] https://www.favini.com/gs/en/fine-papers/crush/carbon-footprint/
[20] https://www.favini.com/gs/wp-content/uploads/2019/02/Azzeroco2_FAVINI_WWW-38-KER_e.pdf

assumed the products are returned in their original packaging to the manufacturer's New York warehouse.

Unit processes were developed using the SimaPro 8.3 LCA model, drawing upon data from multiple sources. Primary data were provided for the manufacturing facilities in addition to supplier locations and transport modes for the product component materials. The principal source of secondary LCI data are the Ecoinvent[21,22] databases. Detailed descriptions of unit processes can be found in the accompanying documentation.

The datasets shown in Table 7 are used in the LCA model to represent the manufacture of materials for *The Humble Shoe Company, Inc.'s AERA* footwear products based on data from completed Data Request Forms (DRFs).

Table 7. LCI datasets and associated databases used to model material production for the AERA footwear products.

Component	Material Dataset	Data Source	Publication Date
PRODUCT			
Outer	Cotton fibre {RoW}| cotton production | Alloc Rec; Nylon 6 {RER}| production | Alloc Rec; Polyethylene terephthalate, granulate, amorphous {RER}| production | Alloc Rec; Polystyrene, general purpose {RER}| production | Alloc Rec; Polyurethane, flexible foam {RER}| production | Alloc Rec; Viscose fibre {GLO}| viscose production | Alloc Rec	Primary data; EI v3.3	2018; 2016
Lining	Viscose fibre {GLO}| viscose production | Alloc Rec ; Polyethylene terephthalate, granulate, amorphous {RER}| production | Alloc Rec; Polyurethane, flexible foam {RER}| production | Alloc Rec	Primary data; EI v3.3	2018; 2016
Sole	Synthetic rubber {RER} | production | Alloc Rec; Clay {CH} | market for clay | Alloc Rec ; Chemical, inorganic {GLO}| market for chemicals, inorganic | Alloc Rec; Chemicals, organic {GLO}| market for | Alloc Rec	EI v3.3	2016
Glue	Latex {GLO}| market for | Alloc Rec	EI v3.3	2016
Heel	- Medium density fibreboard {RER}| medium density fibre board production, uncoated | Alloc Rec; Ethylene vinyl acetate copolymer {RoW}| production | Alloc Rec;	EI v3.3	2016
	- Steel, low-alloyed {RER}| steel production, converter, low-alloyed | Alloc Rec; Acrylonitrile-butadiene-styrene copolymer, 100% recycled {GLO}| market for | Alloc Rec;	EI v3.3	2016
	- Acrylonitrile-butadiene-styrene copolymer, 100% recycled {GLO}| market for | Alloc Rec;	EI v3.3	2016
	- Polyurethane, flexible foam {RER}| production | Alloc Rec;	EI v3.3	2016
	- Medium density fibreboard {RER}| medium density fibre board production, uncoated | Alloc Rec; Polyurethane, rigid foam {RER}| production | Alloc Rec;	EI v3.3	2016
Toplift	Polyurethane, flexible foam {RER}| production | Alloc Rec	EI v3.3	2016

[21] Ecoinvent Centre (2012) Ecoinvent data from v2.2. Swiss Center for Life Cycle Inventories, Dübendorf, 2012 http://www.Ecoinvent.org

[22] Ecoinvent Centre (2016) Ecoinvent data from v3.3. Swiss Center for Life Cycle Inventories, Dübendorf, 2016 http://www.Ecoinvent.org

Component	Material Dataset	Data Source	Publication Date
Insole	Steel, low-alloyed {RER}| steel production, converter, low-alloyed | Alloc Rec; carboxymethyl cellulose, powder {RER}| production | Alloc Rec	EI v3.3	2016
Under-Lining Padding	Polyvinylchloride, bulk polymerised {GLO}| market for | Alloc Rec	EI v3.3	2016
Counterback	Polyethylene terephthalate, granulate, amorphous {RER}| production | Alloc Rec; Synthetic rubber {RER} | production | Alloc Rec; cotton fibre {GLO}| market for | Alloc Rec	EI v3.3	2016
Point	Synthetic rubber {RER} | production | Alloc Rec; cotton fibre {GLO}| market for | Alloc Rec	EI v3.3	2016
Top-Line Tape	Cotton fibre {RoW}| cotton production | Alloc Rec	EI v3.3	2016
Buckle	Zamak3 (Zinc GLO}| market for | Alloc Rec; Aluminium, primary, ingot {IAI Area, EU27 & EFTA}| market for | Alloc Rec; copper {GLO}| market for | Alloc Rec; Magnesium {GLO}| market for | Alloc Rec	EI v3.3	2016
Thread	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Alloc Rec	EI v3.3	2016
Elastic	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Alloc Rec	EI v3.3	2016
Zipper	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Alloc Rec	EI v3.3	2016
Zipper Puller	Zamak3 (Zinc GLO}| market for | Alloc Rec; Aluminium, primary, ingot {IAI Area, EU27 & EFTA}| market for | Alloc Rec; copper {GLO}| market for | Alloc Rec; Magnesium {GLO}| market for | Alloc Rec	EI v3.3	2016
Zipper Tape Puller	Polyethylene terephthalate, granulate, amorphous {GLO}| market for | Alloc Rec	EI v3.3	2016
PACKAGING			
Box	Corrugated board, recycling fibre, double wall, at plant/RER	EI v2.3	2015
Paper Padding	Waste paper, unsorted {GLO}| Recycled Content cut-off | Alloc Rec	EI v3.3	2016
Shoe Bag	Textile, woven cotton {GLO}| market for | Alloc Rec	EI v3.3	2016
RESOURCES			
	Electricity, medium voltage, at grid/{IT} 2017	Primary data; EI v3.3	2017; 2016
TRANSPORTATION			
	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Rec	EI v3.3	2016
	Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Rec	EI v3.3	2016

3.2 Data Quality Assessment

The data quality assessment addresses the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty. Table 8 summarizes the data quality assessment for the study.

Table 8. Data quality assessment for the *AERA* footwear product system LCA.

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage Age of data and the minimum length of time over which data should be collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 10 years old (typically 2015 or more recent). All of the data used represented an average of at least one year's worth of data collection, and up to three years in some cases. Manufacturer-supplied data (primary data) are based on annual production for

Data Quality Parameter	Data Quality Discussion
	2018.
Geographical Coverage Geographical area from which data for unit processes should be collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Actual processes for upstream operations are primarily European. Surrogate data used in the assessment are representative of North American, Global or "Rest-of-World" operations.
Technology Coverage Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations. Electricity consumption for manufacturing is based on regional data for Italy.
Precision Measure of the variability of the data values for each data expressed (e.g. variance)	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the footwear products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness Qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period, and technology coverage)	Data used in the assessment represent typical or average processes as currently reported from multiple data sources, and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used with a bias towards Ecoinvent v3 data where available. Different portions of the product life cycle are equally considered.
Reproducibility Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data Description of all primary and secondary data sources	Data representing energy use at the manufacturing facility represents an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. The Ecoinvent database is used for secondary LCI datasets.
Uncertainty of the Information Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging is low. Actual supplier data for upstream operations was not available for all suppliers and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years), but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment methods include impact potentials, which lack characterization of providing and receiving environments or tipping points.

3.3 LCI Results

The resource use and emissions from each step of the product life cycle are summed to obtain the life cycle inventory results. The LCIA and inventory flow results were calculated using the SimaPro 8.3 model and summarized for a single unit (pair) of each product. Where necessary, the lower heating value is used for energy flow calculations.

Table 9 and Table 10 summarize energy, resource and waste flows for the *AERA* footwear products for the two distribution scenarios considered. Results are presented as an average across all shoes within each of the 12 footwear product lines assessed.

Life cycle inventory results were reviewed for completeness, consistency and representativeness. In addition, sensitivity analyses for several assumed generic processes were evaluated. Overall, with respect to those impact categories assessed, the inventory was considered consistent and generally representative of the system processes as the same types of data sources are used throughout, primarily from the manufacturer, as well as the Ecoinvent life cycle inventory database. As noted previously, all known processes and materials of the product system are included in the inventory.

Table 9. Energy, resource and waste flows for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Product	PED MJ	PERT MJ	PENRT MJ	HWD Kg	NHWD kg	FW m^3
The Platform	113	19.7	92.9	$1.57x10^{-4}$	0.618	0.579
The 95 Pump	89.5	15.4	74.1	$1.36x10^{-4}$	0.432	0.509
The Mule	97.6	17.6	80.0	$1.47x10^{-4}$	0.491	0.602
The 95 Slingback	83.1	14.8	68.4	$1.27x10^{-4}$	0.398	0.487
The 75 Slingback	85.9	14.3	71.6	$1.30x10^{-4}$	0.409	0.470
Ballerina	86.9	14.4	72.6	$1.26x10^{-4}$	0.391	0.493
Slingback Flat	88.0	14.3	73.6	$1.30x10^{-4}$	0.404	0.470
The Slipper	120	20.4	99.2	$1.78x10^{-4}$	0.556	0.653
The Loafer	118	21.7	96.3	$1.72x10^{-4}$	0.554	0.714
The Derby	124	19.7	104	$1.79x10^{-4}$	0.575	0.629
The Ankle Boot	167	28.4	139	$2.51x10^{-4}$	0.860	0.956
The Rockerboot	165	27.5	137	$2.48x10^{-4}$	0.839	0.901

PED = Primary energy demand
PERT = Total use of renewable primary energy resource
PENRT = Total use of non-renewable primary energy resources
FW = Net use of fresh water
HWD = Hazardous waste disposed
NHWD = Non-hazardous waste disposed

Table 10. Energy, resource and waste flows for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Product	PED MJ	PERT MJ	PENRT MJ	HWD Kg	NHWD kg	FW m^3
The Platform	253	20.3	233	1.95×10^{-4}	0.671	0.626
The 95 Pump	169	15.7	153	1.57×10^{-4}	0.463	0.536
The Mule	184	17.9	167	1.71×10^{-4}	0.524	0.631
The 95 Slingback	159	15.1	144	1.47×10^{-4}	0.427	0.512
The 75 Slingback	164	14.6	149	1.52×10^{-4}	0.439	0.496
Ballerina	160	14.7	145	1.46×10^{-4}	0.418	0.517
Slingback Flat	165	14.6	150	1.51×10^{-4}	0.433	0.496
The Slipper	224	20.8	203	2.07×10^{-4}	0.596	0.688
The Loafer	221	22.1	199	2.00×10^{-4}	0.593	0.748
The Derby	231	20.1	211	2.08×10^{-4}	0.616	0.665
The Ankle Boot	323	29.0	294	2.93×10^{-4}	0.919	1.01
The Rockerboot	320	28.1	292	2.90×10^{-4}	0.898	0.953

PED = Primary energy demand
PERT = Total use of renewable primary energy resource
PENRT = Total use of non-renewable primary energy resources
FW = Net use of fresh water
HWD = Hazardous waste disposed
NHWD = Non-hazardous waste disposed

4. Life Cycle Impact Assessment (LCIA)

From the LCI data, impact assessment results are calculated. LCIA methodologies are used to relate the LCI results to the associated environmental impacts, where the LCI results are classified within impact categories, each with a category indicator. The choice of methods and indicators used in the assessment are based on the requirements of ISO 14044.

It should be noted that the LCIA results presented below are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Additionally, the environmental relevance of LCIA results is not affected by LCI functional unit calculation, system wide averaging, aggregation and allocation.

4.1 Indicator calculations

Impact category indicators are estimated using the TRACI 2.1 and CML-IA characterization methodologies including acidification potential, eutrophication potential, photochemical ozone creation potential, abiotic resource depletion potential and global warming potential.

Category impact indicators for the *AERA footwear* products distributed by ocean freighter are summarized in Table 11 and Table 12 using the TRACI and CML characterization methodologies, respectively. Corresponding results for distribution via air freight are presented in Table 13 and Table 14. Results are presented per functional unit of one pair of AERA footwear, averaged across all products within each of the twelve (12) product style lines. Impact indicator results for each individual footwear product are included as an Appendix. In general, depending on the indicator and product, the deviation of the results from the average across styles range from approximately ±1% to 10%.

Table 11. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Parameter Product	GWP kg CO_2 eq	ODP kg CFC-11 eq	AP kg SO_2 eq	EP kg N eq	POCP kg O_3 eq	FFD MJ surplus
The Platform	5.99	5.38×10^{-6}	2.69×10^{-2}	1.56×10^{-2}	0.325	9.79
The 95 Pump	5.06	5.28×10^{-6}	2.19×10^{-2}	1.31×10^{-2}	0.247	7.44
The Mule	5.47	5.31×10^{-6}	2.42×10^{-2}	1.45×10^{-2}	0.270	8.06
The 95 Slingback	4.73	5.25×10^{-6}	2.05×10^{-2}	1.23×10^{-2}	0.231	6.77
The 75 Slingback	4.88	5.26×10^{-6}	2.08×10^{-2}	1.24×10^{-2}	0.237	7.16
Ballerina	4.93	5.25×10^{-6}	2.10×10^{-2}	1.22×10^{-2}	0.235	7.36
Slingback Flat	4.98	5.26×10^{-6}	2.11×10^{-2}	1.23×10^{-2}	0.240	7.45
The Slipper	6.68	6.21×10^{-6}	2.83×10^{-2}	1.63×10^{-2}	0.321	10.1
The Loafer	6.59	6.21×10^{-6}	2.85×10^{-2}	1.68×10^{-2}	0.321	9.76
The Derby	6.92	6.21×10^{-6}	2.89×10^{-2}	1.65×10^{-2}	0.331	10.7
The Ankle Boot	9.44	1.04×10^{-5}	4.18×10^{-2}	2.55×10^{-2}	0.475	14.0
The Rockerboot	9.30	1.04×10^{-5}	4.09×10^{-2}	2.47×10^{-2}	0.467	13.8

GWP - Global Warming Potential
ODP - Ozone Layer Depletion Potential
AP - Acidification Potential
EP - Eutrophication Potential
POCP - Smog Creation Potential
FFD - Fossil Fuel Depletion Potential

Table 12. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Parameter	GWP	ODP	AP	EP	POCP	ADPE	ADPF
Product	kg CO_2 eq	kg CFC-11 eq	kg SO_2 eq	kg $(PO_4)^{3-}$ eq	kg C_2H_4 eq	kg Sb eq	MJ eq
The Platform	6.09	5.38×10^{-6}	2.66×10^{-2}	8.27×10^{-3}	1.34×10^{-3}	4.42×10^{-5}	84.9
The 95 Pump	5.15	5.28×10^{-6}	2.19×10^{-2}	6.82×10^{-3}	1.09×10^{-3}	1.02×10^{-5}	67.2
The Mule	5.57	5.31×10^{-6}	2.42×10^{-2}	7.58×10^{-3}	1.19×10^{-3}	1.00×10^{-5}	72.5
The 95 Slingback	4.81	5.25×10^{-6}	2.05×10^{-2}	6.43×10^{-3}	1.01×10^{-3}	9.07×10^{-6}	61.9
The 75 Slingback	4.96	5.26×10^{-6}	2.09×10^{-2}	6.46×10^{-3}	1.04×10^{-3}	9.03×10^{-6}	64.8
Ballerina	5.02	5.25×10^{-6}	2.11×10^{-2}	6.39×10^{-3}	1.03×10^{-3}	8.75×10^{-6}	65.8
Slingback Flat	5.06	5.26×10^{-6}	2.12×10^{-2}	6.43×10^{-3}	1.06×10^{-3}	9.02×10^{-6}	66.7
The Slipper	6.80	6.21×10^{-6}	2.83×10^{-2}	8.56×10^{-3}	1.42×10^{-3}	1.18×10^{-5}	90.1
The Loafer	6.71	6.21×10^{-6}	2.84×10^{-2}	8.82×10^{-3}	1.40×10^{-3}	1.20×10^{-5}	87.4
The Derby	7.04	6.21×10^{-6}	2.90×10^{-2}	8.62×10^{-3}	1.47×10^{-3}	1.18×10^{-5}	94.2
The Ankle Boot	9.61	1.04×10^{-5}	4.17×10^{-2}	1.33×10^{-2}	2.07×10^{-3}	4.94×10^{-5}	126
The Rockerboot	9.46	1.04×10^{-5}	4.09×10^{-2}	1.28×10^{-2}	2.05×10^{-3}	4.90×10^{-5}	124

GWP - Global Warming Potential
ODP - Ozone Layer Depletion Potential
AP - Acidification Potential
EP - Eutrophication Potential
POCP - Photochemical Oxidant Creation Potential
ADPE - Abiotic Depletion Potential (elements)
ADPF - Abiotic Depletion Potential (fossil fuels)

Table 13. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Parameter	GWP	ODP	AP	EP	POCP	FFD
Product	kg CO_2 eq	kg CFC-11 eq	kg SO_2 eq	kg N eq	kg O_3 eq	MJ surplus
The Platform	15.1	7.06×10^{-6}	6.46×10^{-2}	2.18×10^{-2}	1.26	29.5
The 95 Pump	10.2	6.22×10^{-6}	4.32×10^{-2}	1.66×10^{-2}	0.773	18.6
The Mule	11.1	6.35×10^{-6}	4.75×10^{-2}	1.83×10^{-2}	0.847	20.3
The 95 Slingback	9.67	6.16×10^{-6}	4.09×10^{-2}	1.56×10^{-2}	0.737	17.5
The 75 Slingback	9.93	6.19×10^{-6}	4.17×10^{-2}	1.58×10^{-2}	0.753	18.1
Ballerina	9.64	6.11×10^{-6}	4.05×10^{-2}	1.54×10^{-2}	0.718	17.6
Slingback Flat	9.95	6.17×10^{-6}	4.17×10^{-2}	1.57×10^{-2}	0.748	18.2
The Slipper	13.5	7.46×10^{-6}	5.63×10^{-2}	2.09×10^{-2}	1.02	24.8
The Loafer	13.3	7.45×10^{-6}	5.62×10^{-2}	2.13×10^{-2}	1.01	24.3
The Derby	13.9	7.49×10^{-6}	5.76×10^{-2}	2.12×10^{-2}	1.04	25.8
The Ankle Boot	19.5	1.23×10^{-5}	8.33×10^{-2}	3.23×10^{-2}	1.50	35.8
The Rockerboot	19.4	1.23×10^{-5}	8.25×10^{-2}	3.15×10^{-2}	1.50	35.6

GWP - Global Warming Potential
ODP - Ozone Layer Depletion Potential
AP - Acidification Potential
EP - Eutrophication Potential
POCP - Smog Creation Potential
FFD - Fossil Fuel Depletion Potential

Table 14. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

Parameter	GWP	ODP	AP	EP	POCP	ADPE	ADPF
Product	kg CO_2 eq	kg CFC-11 eq	kg SO_2 eq	kg $(PO_4)^{3-}$ eq	kg C_2H_4 eq	kg Sb eq	MJ eq
The Platform	15.2	$7.06x10^{-6}$	$5.90x10^{-2}$	$1.45x10^{-2}$	$2.75x10^{-3}$	$4.51x10^{-5}$	224
The 95 Pump	10.3	$6.22x10^{-6}$	$4.02x10^{-2}$	$1.03x10^{-2}$	$1.89x10^{-3}$	$1.07x10^{-5}$	146
The Mule	11.2	$6.35x10^{-6}$	$4.42x10^{-2}$	$1.14x10^{-2}$	$2.06x10^{-3}$	$1.06x10^{-5}$	159
The 95 Slingback	9.77	$6.16x10^{-6}$	$3.80x10^{-2}$	$9.79x10^{-3}$	$1.78x10^{-3}$	$9.55x10^{-6}$	137
The 75 Slingback	10.0	$6.19x10^{-6}$	$3.88x10^{-2}$	$9.89x10^{-3}$	$1.83x10^{-3}$	$9.52x10^{-6}$	142
Ballerina	9.75	$6.11x10^{-6}$	$3.78x10^{-2}$	$9.60x10^{-3}$	$1.76x10^{-3}$	$9.21x10^{-6}$	138
Slingback Flat	10.0	$6.17x10^{-6}$	$3.89x10^{-2}$	$9.82x10^{-3}$	$1.83x10^{-3}$	$9.50x10^{-6}$	143
The Slipper	13.6	$7.46x10^{-6}$	$5.24x10^{-2}$	$1.32x10^{-2}$	$2.47x10^{-3}$	$1.25x10^{-5}$	194
The Loafer	13.4	$7.45x10^{-6}$	$5.23x10^{-2}$	$1.34x10^{-2}$	$2.43x10^{-3}$	$1.26x10^{-5}$	190
The Derby	14.0	$7.49x10^{-6}$	$5.37x10^{-2}$	$1.34x10^{-2}$	$2.55x10^{-3}$	$1.24x10^{-5}$	200
The Ankle Boot	19.7	$1.23x10^{-5}$	$7.75x10^{-2}$	$2.01x10^{-2}$	$3.63x10^{-3}$	$5.04x10^{-5}$	279
The Rockerboot	19.6	$1.23x10^{-5}$	$7.66x10^{-2}$	$1.97x10^{-2}$	$3.61x10^{-3}$	$4.99x10^{-5}$	278

GWP - Global Warming Potential
ODP - Ozone Layer Depletion Potential
AP - Acidification Potential
EP - Eutrophication Potential
POCP - Photochemical Oxidant Creation Potential
ADPE - Abiotic Depletion Potential (elements)
ADPF - Abiotic Depletion Potential (fossil fuels)

4.2 Contribution Analysis

Life cycle modeling of the *AERA* footwear was divided into distinct life cycle phases, including raw material extraction and processing, product manufacturing and product distribution and returns. A detailed examination of the potential environmental impacts provides some insight into the relative contributions from each of the product's life cycle phases.

The following life cycle phases were included in the contribution analysis (See also Table 2):

- *Raw Materials Processing (Sourcing/Extraction)* **–** This stage includes extraction of virgin materials and reclamation of non-virgin feedstock. Resource use and emissions associated with both extraction of the raw materials and product component manufacturing are included.
- *Transport* – The impacts associated with transport of the product component materials to the manufacturing facilities are included in this stage.
- *Manufacturing* **–** This stage includes all the relevant manufacturing processes and flows, including the impacts from energy use and emissions at the fabrication facilities. Production of capital goods, infrastructure, manufacturing equipment, and personnel-related activities are not included.
- *Packaging* – This stage includes the production of the product packaging materials.

- *Distribution* – This stage includes delivery of the product to the point of use (downstream transportation). Also included are impacts associated with the transport of the returned products.

TRACI category indicator results for the *AERA* footwear products are summarized in Table 15 through Table 20 for the ocean freight distribution scenario, while Table 21 through Table 26 present category indicator results for the air freight product distribution scenario. Results are summarized by life cycle phase for each product, per functional unit (i.e., per single pair of a footwear), averaged across each product style line. Percent contributions are also presented. TRACI results are shown graphical in Figure 3 through Figure 8 while Figure 9 through Figure 14 presnt results based on the CML characterization methodology.

For the ocean freight distribution scenario, depending on the impact category indicators assessed, the main contributions to indicator results, are primarily from the product manufacturing, followed by the product packaging and material extraction and processing. Contributions from product distribution are generally less than 10% of the total impact, while upstream material transport impacts are negligible, as expected.

For the air freight distribution scenario, the main contributions to indicator results are primarily from the product distribution, followed by manufacturing of the footwear, packaging and material extraction and processing phases. It is noted that, based on the ecoinvent data used for modeling, potential impacts from air freight transport are nearly 100x those for ocean freighter transport, on a per ton-km basis, depending on the impact category indicator assessed.

The relatively large contribution of the product packaging is due mainly to the impacts from the processing required to manufacture the cotton fabric material, as modeled using secondary data from Ecoinvent.

Table 15. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI - Global Warming Potential (GWP)

GWP (kg CO_2 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	1.51	$7.50x10^{-3}$	1.99	1.89	0.597
	25%	0.13%	33%	32%	10.0%
The 95 Pump	1.17	$7.04x10^{-3}$	1.99	1.56	0.337
	23%	0.14%	39%	31%	6.7%
The Mule	1.55	$9.67x10^{-3}$	1.99	1.56	0.369
	28%	0.18%	36%	28%	6.7%
The 95 Slingback	0.860	$4.47x10^{-3}$	1.99	1.56	0.323
	18%	0.09%	42%	33%	6.8%
The 75 Slingback	1.00	$5.21x10^{-3}$	1.99	1.56	0.330
	20%	0.11%	41%	32%	6.8%
Ballerina	1.07	$7.08x10^{-3}$	1.99	1.56	0.308
	22%	0.14%	40%	32%	6.3%
Slingback Flat	1.10	$6.98x10^{-3}$	1.99	1.56	0.325
	22%	0.14%	40%	31%	6.5%
The Slipper	1.49	$9.61x10^{-3}$	2.82	1.91	0.444
	22%	0.14%	42%	29%	6.6%
The Loafer	1.41	$9.18x10^{-3}$	2.82	1.91	0.439
	21%	0.14%	43%	29%	6.7%
The Derby	1.72	$1.05x10^{-2}$	2.82	1.91	0.454
	25%	0.15%	41%	28%	6.6%
The Ankle Boot	2.75	$1.86x10^{-2}$	2.82	3.19	0.658
	29%	0.20%	30%	34%	7.0%
The Rockerboot	2.60	$1.86x10^{-2}$	2.82	3.19	0.658
	28%	0.20%	30%	34%	7.1%

Table 16. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI – Ozone Depletion Potential (ODP)

ODP (kg CFC-11 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	$1.31x10^{-7}$	$1.39x10^{-9}$	$2.32x10^{-7}$	$4.91x10^{-6}$	$1.07x10^{-7}$
	2.4%	0.03%	4.3%	91%	2.0%
The 95 Pump	$1.12x10^{-7}$	$1.30x10^{-9}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$6.05x10^{-8}$
	2.1%	0.02%	4.4%	92%	1.1%
The Mule	$1.43x10^{-7}$	$1.79x10^{-9}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$6.63x10^{-8}$
	2.7%	0.03%	4.4%	92%	1.2%
The 95 Slingback	$9.24x10^{-8}$	$8.28x10^{-10}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$5.81x10^{-8}$
	1.8%	0.02%	4.4%	93%	1.1%
The 75 Slingback	$9.43x10^{-8}$	$9.64x10^{-10}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$5.93x10^{-8}$
	1.8%	0.02%	4.4%	93%	1.1%
Ballerina	$8.54x10^{-8}$	$1.31x10^{-9}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$5.54x10^{-8}$
	1.6%	0.02%	4.4%	93%	1.1%
Slingback Flat	$9.36x10^{-8}$	$1.29x10^{-9}$	$2.32x10^{-7}$	$4.87x10^{-6}$	$5.84x10^{-8}$
	1.8%	0.02%	4.4%	93%	1.1%
The Slipper	$1.36x10^{-7}$	$1.78x10^{-9}$	$3.30x10^{-7}$	$5.66x10^{-6}$	$7.98x10^{-8}$
	2.2%	0.03%	5.3%	91%	1.3%
The Loafer	$1.40x10^{-7}$	$1.70x10^{-9}$	$3.30x10^{-7}$	$5.66x10^{-6}$	$7.89x10^{-8}$
	2.3%	0.03%	5.3%	91%	1.3%
The Derby	$1.35x10^{-7}$	$1.95x10^{-9}$	$3.30x10^{-7}$	$5.66x10^{-6}$	$8.17x10^{-8}$
	2.2%	0.03%	5.3%	91%	1.3%
The Ankle Boot	$2.14x10^{-7}$	$3.45x10^{-9}$	$3.30x10^{-7}$	$9.75x10^{-6}$	$1.18x10^{-7}$
	2.1%	0.03%	3.2%	94%	1.1%
The Rockerboot	$2.04x10^{-7}$	$3.45x10^{-9}$	$3.30x10^{-7}$	$9.75x10^{-6}$	$1.18x10^{-7}$
	2.0%	0.03%	3.2%	94%	1.1%

Table 17. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI - Acidification Potential (AP)

AP (kg SO_2 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	$7.25x10^{-3}$ 27%	$3.45x10^{-5}$ 0.13%	$6.24x10^{-3}$ 23%	$8.51x10^{-3}$ 32%	$4.85x10^{-3}$ 18%
The 95 Pump	$5.48x10^{-3}$ 25%	$3.24x10^{-5}$ 0.15%	$6.24x10^{-3}$ 28%	$7.42x10^{-3}$ 34%	$2.74x10^{-3}$ 13%
The Mule	$7.50x10^{-3}$ 31%	$4.45x10^{-5}$ 0.18%	$6.24x10^{-3}$ 26%	$7.42x10^{-3}$ 31%	$3.00x10^{-3}$ 12%
The 95 Slingback	$4.16x10^{-3}$ 20%	$2.06x10^{-5}$ 0.10%	$6.24x10^{-3}$ 30%	$7.42x10^{-3}$ 36%	$2.63x10^{-3}$ 13%
The 75 Slingback	$4.45x10^{-3}$ 21%	$2.40x10^{-5}$ 0.12%	$6.24x10^{-3}$ 30%	$7.42x10^{-3}$ 36%	$2.69x10^{-3}$ 13%
Ballerina	$4.83x10^{-3}$ 23%	$3.26x10^{-5}$ 0.15%	$6.24x10^{-3}$ 30%	$7.42x10^{-3}$ 35%	$2.51x10^{-3}$ 12%
Slingback Flat	$4.81x10^{-3}$ 23%	$3.21x10^{-5}$ 0.15%	$6.24x10^{-3}$ 29%	$7.42x10^{-3}$ 35%	$2.65x10^{-3}$ 13%
The Slipper	$6.81x10^{-3}$ 24%	$4.42x10^{-5}$ 0.16%	$8.86x10^{-3}$ 31%	$8.95x10^{-3}$ 32%	$3.61x10^{-3}$ 13%
The Loafer	$7.07x10^{-3}$ 25%	$4.22x10^{-5}$ 0.15%	$8.86x10^{-3}$ 31%	$8.95x10^{-3}$ 31%	$3.57x10^{-3}$ 13%
The Derby	$7.32x10^{-3}$ 25%	$4.85x10^{-5}$ 0.17%	$8.86x10^{-3}$ 31%	$8.95x10^{-3}$ 31%	$3.70x10^{-3}$ 13%
The Ankle Boot	$1.24x10^{-2}$ 30%	$8.58x10^{-5}$ 0.21%	$8.86x10^{-3}$ 21%	$1.51x10^{-2}$ 36%	$5.36x10^{-3}$ 13%
The Rockerboot	$1.15x10^{-2}$ 28%	$8.58x10^{-5}$ 0.21%	$8.86x10^{-3}$ 22%	$1.51x10^{-2}$ 37%	$5.36x10^{-3}$ 13%

Table 18. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI - Eutrophication Potential (EP)

EP (kg N eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	4.90×10^{-3} 31%	8.37×10^{-6} 0.05%	2.54×10^{-3} 16%	7.44×10^{-3} 48%	7.56×10^{-4} 4.8%
The 95 Pump	3.84×10^{-3} 29%	7.85×10^{-6} 0.06%	2.54×10^{-3} 19%	6.27×10^{-3} 48%	4.26×10^{-4} 3.3%
The Mule	5.22×10^{-3} 36%	1.08×10^{-5} 0.07%	2.54×10^{-3} 18%	6.27×10^{-3} 43%	4.67×10^{-4} 3.2%
The 95 Slingback	3.08×10^{-3} 25%	4.99×10^{-6} 0.04%	2.54×10^{-3} 21%	6.27×10^{-3} 51%	4.10×10^{-4} 3.3%
The 75 Slingback	3.17×10^{-3} 26%	5.81×10^{-6} 0.05%	2.54×10^{-3} 20%	6.27×10^{-3} 51%	4.18×10^{-4} 3.4%
Ballerina	3.01×10^{-3} 25%	7.89×10^{-6} 0.06%	2.54×10^{-3} 21%	6.27×10^{-3} 51%	3.91×10^{-4} 3.2%
Slingback Flat	3.09×10^{-3} 25%	7.78×10^{-6} 0.06%	2.54×10^{-3} 21%	6.27×10^{-3} 51%	4.12×10^{-4} 3.3%
The Slipper	4.50×10^{-3} 28%	1.07×10^{-5} 0.07%	3.61×10^{-3} 22%	7.64×10^{-3} 47%	5.63×10^{-4} 3.4%
The Loafer	4.95×10^{-3} 30%	1.02×10^{-5} 0.06%	3.61×10^{-3} 22%	7.64×10^{-3} 46%	5.56×10^{-4} 3.3%
The Derby	4.66×10^{-3} 28%	1.17×10^{-5} 0.07%	3.61×10^{-3} 22%	7.64×10^{-3} 46%	5.76×10^{-4} 3.5%
The Ankle Boot	8.24×10^{-3} 32%	2.08×10^{-5} 0.08%	3.61×10^{-3} 14%	1.28×10^{-2} 50%	8.34×10^{-4} 3.3%
The Rockerboot	7.39×10^{-3} 30%	2.08×10^{-5} 0.08%	3.61×10^{-3} 15%	1.28×10^{-2} 52%	8.34×10^{-4} 3.4%

Table 19. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI – Smog Creation Potential (POCP)

POCP (kg O3 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	7.52×10^{-2}	8.13×10^{-4}	5.97×10^{-2}	9.85×10^{-2}	9.10×10^{-2}
	23%	0.25%	18%	30%	28%
The 95 Pump	5.66×10^{-2}	7.63×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	5.13×10^{-2}
	23%	0.31%	24%	32%	21%
The Mule	7.46×10^{-2}	1.05×10^{-3}	5.97×10^{-2}	7.82×10^{-2}	5.62×10^{-2}
	28%	0.39%	22%	29%	21%
The 95 Slingback	4.37×10^{-2}	4.84×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	4.93×10^{-2}
	19%	0.21%	26%	34%	21%
The 75 Slingback	4.83×10^{-2}	5.64×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	5.03×10^{-2}
	20%	0.24%	25%	33%	21%
Ballerina	4.92×10^{-2}	7.67×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	4.70×10^{-2}
	21%	0.33%	25%	33%	20%
Slingback Flat	5.14×10^{-2}	7.56×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	4.96×10^{-2}
	21%	0.32%	25%	33%	21%
The Slipper	7.03×10^{-2}	1.04×10^{-3}	8.48×10^{-2}	9.71×10^{-2}	6.77×10^{-2}
	22%	0.32%	26%	30%	21%
The Loafer	7.09×10^{-2}	9.94×10^{-4}	8.48×10^{-2}	9.71×10^{-2}	6.69×10^{-2}
	22%	0.31%	26%	30%	21%
The Derby	7.86×10^{-2}	1.14×10^{-3}	8.48×10^{-2}	9.71×10^{-2}	6.93×10^{-2}
	24%	0.34%	26%	29%	21%
The Ankle Boot	0.126	2.02×10^{-3}	8.48×10^{-2}	0.161	0.100
	27%	0.43%	18%	34%	21%
The Rockerboot	0.118	2.02×10^{-3}	8.48×10^{-2}	0.161	0.100
	25%	0.43%	18%	35%	22%

Table 20. Contribution Analysis Results for the *AERA* footwear products. Product distribution via ocean freighter. Results are shown for a single pair of shoes. TRACI – Fossil Fuel Depletion (FFD)

FFD (MJ eq.)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	3.39	1.65×10^{-2}	3.18	1.94	1.27
	35%	0.17%	32%	20%	13%
The 95 Pump	2.18	1.54×10^{-2}	3.18	1.35	0.716
	29%	0.21%	43%	18%	9.6%
The Mule	2.73	2.12×10^{-2}	3.18	1.35	0.784
	34%	0.26%	39%	17%	9.7%
The 95 Slingback	1.55	9.81×10^{-3}	3.18	1.35	0.687
	23%	0.14%	47%	20%	10%
The 75 Slingback	1.92	1.14×10^{-2}	3.18	1.35	0.702
	27%	0.16%	44%	19%	9.8%
Ballerina	2.17	1.55×10^{-2}	3.18	1.35	0.656
	29%	0.21%	43%	18%	8.9%
Slingback Flat	2.22	1.53×10^{-2}	3.18	1.35	0.691
	30%	0.21%	43%	18%	9.3%
The Slipper	2.92	2.11×10^{-2}	4.51	1.75	0.944
	29%	0.21%	44%	17%	9.3%
The Loafer	2.54	2.01×10^{-2}	4.51	1.75	0.934
	26%	0.21%	46%	18%	9.6%
The Derby	3.47	2.31×10^{-2}	4.51	1.75	0.966
	32%	0.22%	42%	16%	9.0%
The Ankle Boot	5.19	4.09×10^{-2}	4.51	2.84	1.40
	37%	0.29%	32%	20%	10%
The Rockerboot	5.05	4.09×10^{-2}	4.51	2.84	1.40
	36%	0.30%	33%	21%	10%

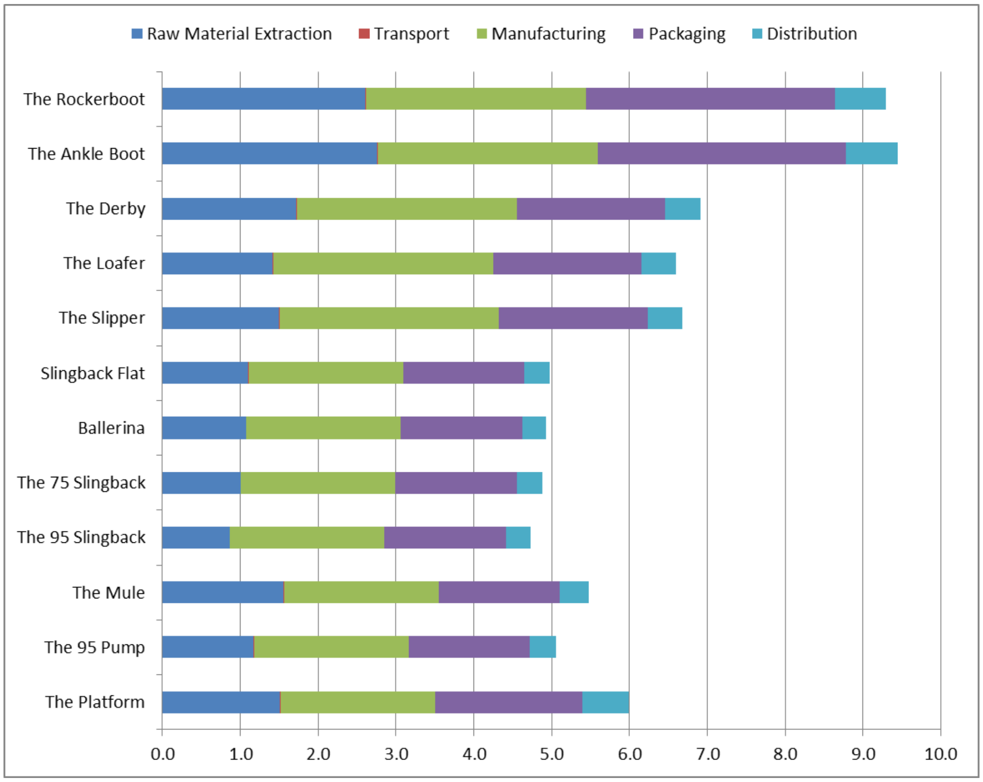

Figure 3. Percent contribution analysis for the *AREA* footwear products. - GWP

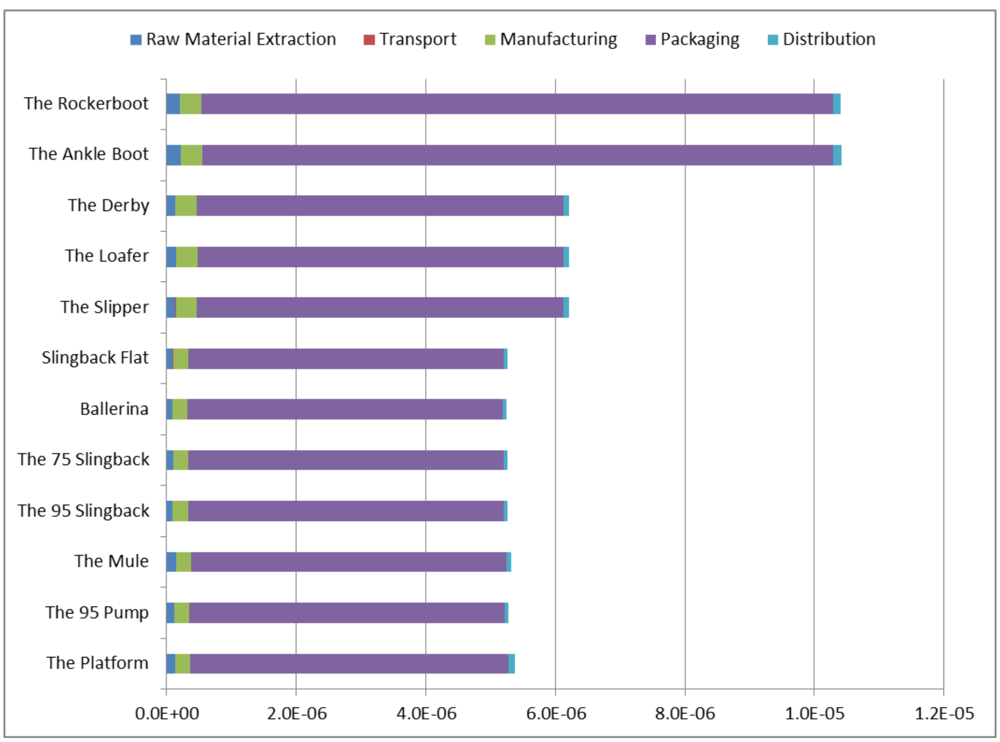

Figure 4. Percent contribution analysis for the *AREA* footwear products. - ODP

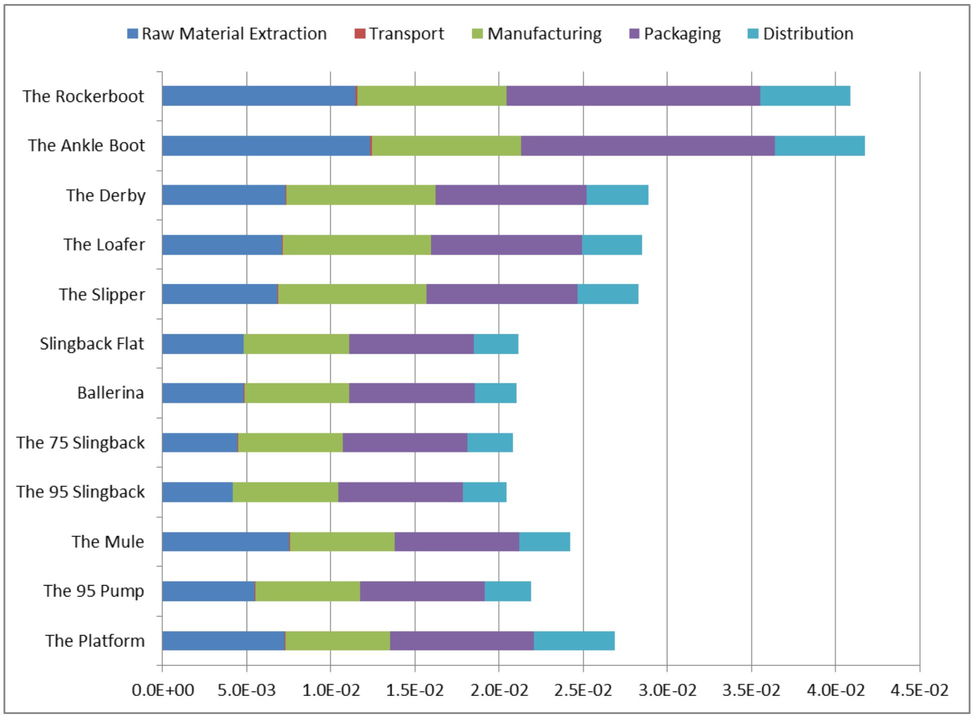

Figure 5. Percent contribution analysis for the *AREA* footwear products. - AP

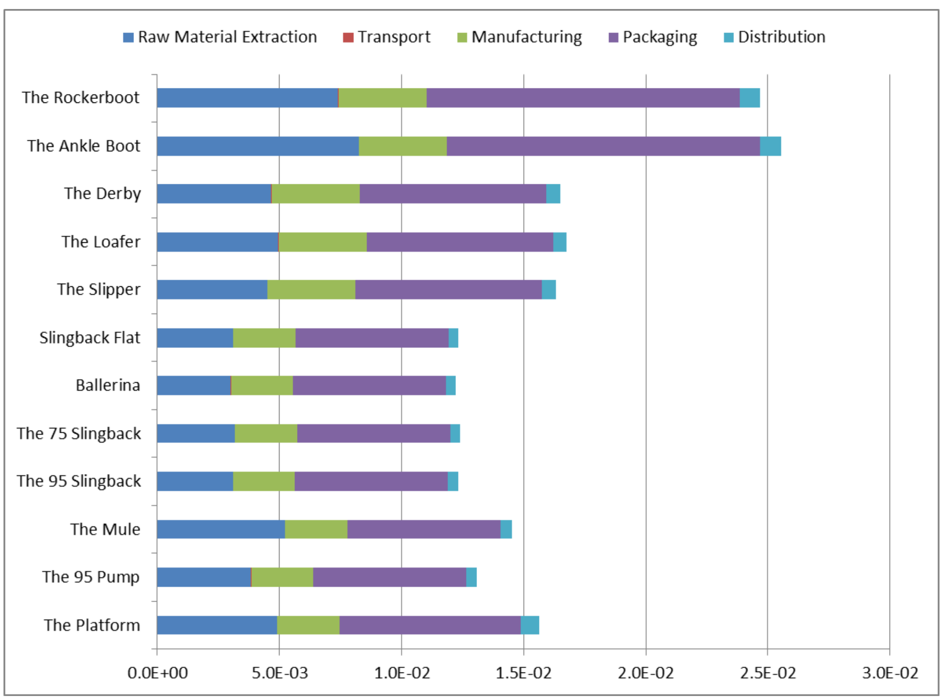

Figure 6. Percent contribution analysis for the *AREA* footwear products. - EP

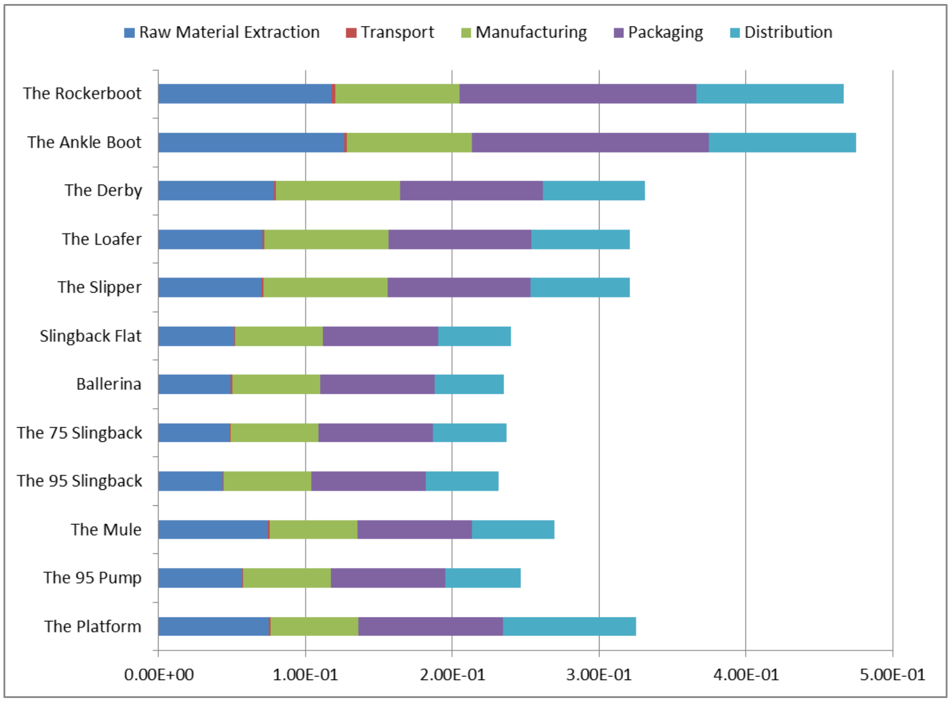

Figure 7. Percent contribution analysis for the *AREA* footwear products. - POCP

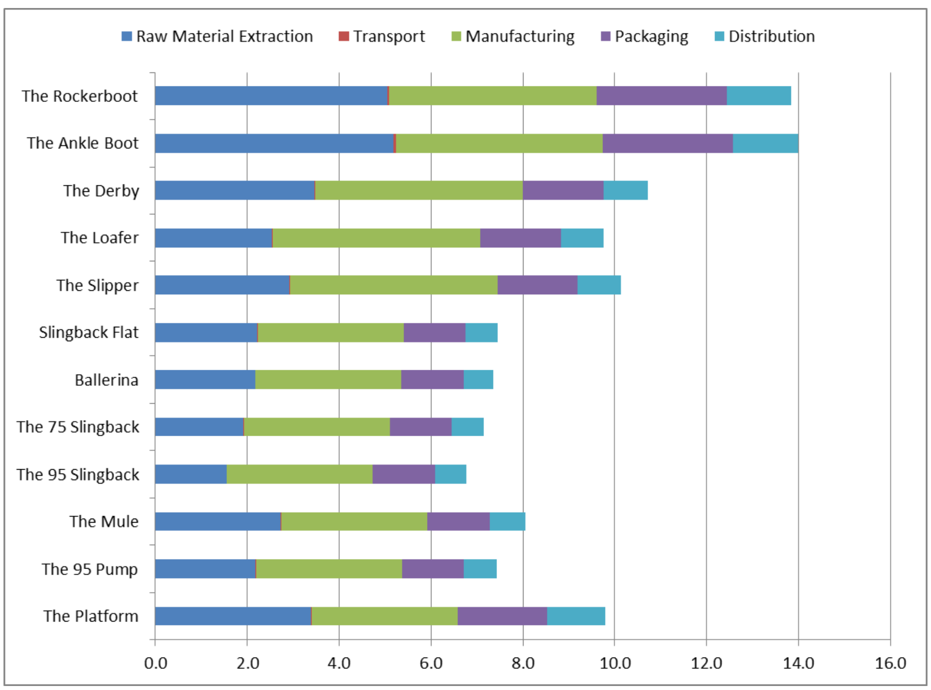

Figure 8. Percent contribution analysis for the *AREA* footwear products. - FFD

Table 21. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI - Global Warming Potential (GWP)

GWP (kg CO_2 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	1.51	7.50×10^{-3}	1.99	1.89	9.72
	10.0%	0.05%	13%	12%	64%
The 95 Pump	1.17	7.04×10^{-3}	1.99	1.56	5.48
	11%	0.07%	19%	15%	54%
The Mule	1.55	9.67×10^{-3}	1.99	1.56	6.01
	14%	0.09%	18%	14%	54%
The 95 Slingback	0.860	4.47×10^{-3}	1.99	1.56	5.27
	8.9%	0.05%	21%	16%	54%
The 75 Slingback	1.00	5.21×10^{-3}	1.99	1.56	5.38
	10%	0.05%	20%	16%	54%
Ballerina	1.07	7.08×10^{-3}	1.99	1.56	5.02
	11%	0.07%	21%	16%	52%
Slingback Flat	1.10	6.98×10^{-3}	1.99	1.56	5.30
	11%	0.07%	20%	16%	53%
The Slipper	1.49	9.61×10^{-3}	2.82	1.91	7.23
	11%	0.07%	21%	14%	54%
The Loafer	1.41	9.18×10^{-3}	2.82	1.91	7.15
	11%	0.07%	21%	14%	54%
The Derby	1.72	1.05×10^{-2}	2.82	1.91	7.40
	12%	0.08%	20%	14%	53%
The Ankle Boot	2.75	1.86×10^{-2}	2.82	3.19	10.7
	14%	0.10%	14%	16%	55%
The Rockerboot	2.60	1.86×10^{-2}	2.82	3.19	10.7
	13%	0.10%	15%	16%	55%

Table 22. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI – Ozone Depletion Potential (ODP)

ODP (kg CFC-11 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	1.31×10^{-7} 1.9%	1.39×10^{-9} 0.02%	2.32×10^{-7} 3.3%	4.91×10^{-6} 70%	1.79×10^{-6} 25%
The 95 Pump	1.12×10^{-7} 1.8%	1.30×10^{-9} 0.02%	2.32×10^{-7} 3.7%	4.87×10^{-6} 78%	1.01×10^{-6} 16%
The Mule	1.43×10^{-7} 2.3%	1.79×10^{-9} 0.03%	2.32×10^{-7} 3.7%	4.87×10^{-6} 77%	1.10×10^{-6} 17%
The 95 Slingback	9.24×10^{-8} 1.5%	8.28×10^{-10} 0.01%	2.32×10^{-7} 3.8%	4.87×10^{-6} 79%	9.68×10^{-7} 16%
The 75 Slingback	9.43×10^{-8} 1.5%	9.64×10^{-10} 0.02%	2.32×10^{-7} 3.8%	4.87×10^{-6} 79%	9.88×10^{-7} 16%
Ballerina	8.54×10^{-8} 1.4%	1.31×10^{-9} 0.02%	2.32×10^{-7} 3.8%	4.87×10^{-6} 80%	9.24×10^{-7} 15%
Slingback Flat	9.36×10^{-8} 1.5%	1.29×10^{-9} 0.02%	2.32×10^{-7} 3.8%	4.87×10^{-6} 79%	9.74×10^{-7} 16%
The Slipper	1.36×10^{-7} 1.8%	1.78×10^{-9} 0.02%	3.30×10^{-7} 4.4%	5.66×10^{-6} 76%	1.33×10^{-6} 18%
The Loafer	1.40×10^{-7} 1.9%	1.70×10^{-9} 0.02%	3.30×10^{-7} 4.4%	5.66×10^{-6} 76%	1.31×10^{-6} 18%
The Derby	1.35×10^{-7} 1.8%	1.95×10^{-9} 0.03%	3.30×10^{-7} 4.4%	5.66×10^{-6} 76%	1.36×10^{-6} 18%
The Ankle Boot	2.14×10^{-7} 1.7%	3.45×10^{-9} 0.03%	3.30×10^{-7} 2.7%	9.75×10^{-6} 79%	1.97×10^{-6} 16%
The Rockerboot	2.04×10^{-7} 1.7%	3.45×10^{-9} 0.03%	3.30×10^{-7} 2.7%	9.75×10^{-6} 80%	1.97×10^{-6} 16%

Table 23. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI - Acidification Potential (AP)

AP (kg SO_2 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	$7.25x10^{-3}$ 11%	$3.45x10^{-5}$ 0.05%	$6.24x10^{-3}$ 9.7%	$8.51x10^{-3}$ 13%	$4.25x10^{-2}$ 66%
The 95 Pump	$5.48x10^{-3}$ 13%	$3.24x10^{-5}$ 0.08%	$6.24x10^{-3}$ 14%	$7.42x10^{-3}$ 17%	$2.40x10^{-2}$ 56%
The Mule	$7.50x10^{-3}$ 16%	$4.45x10^{-5}$ 0.09%	$6.24x10^{-3}$ 13%	$7.42x10^{-3}$ 16%	$2.63x10^{-2}$ 55%
The 95 Slingback	$4.16x10^{-3}$ 10%	$2.06x10^{-5}$ 0.05%	$6.24x10^{-3}$ 15%	$7.42x10^{-3}$ 18%	$2.30x10^{-2}$ 56%
The 75 Slingback	$4.45x10^{-3}$ 11%	$2.40x10^{-5}$ 0.06%	$6.24x10^{-3}$ 15%	$7.42x10^{-3}$ 18%	$2.35x10^{-2}$ 56%
Ballerina	$4.83x10^{-3}$ 12%	$3.26x10^{-5}$ 0.08%	$6.24x10^{-3}$ 15%	$7.42x10^{-3}$ 18%	$2.20x10^{-2}$ 54%
Slingback Flat	$4.81x10^{-3}$ 12%	$3.21x10^{-5}$ 0.08%	$6.24x10^{-3}$ 15%	$7.42x10^{-3}$ 18%	$2.32x10^{-2}$ 56%
The Slipper	$6.81x10^{-3}$ 12%	$4.42x10^{-5}$ 0.08%	$8.86x10^{-3}$ 16%	$8.95x10^{-3}$ 16%	$3.17x10^{-2}$ 56%
The Loafer	$7.07x10^{-3}$ 13%	$4.22x10^{-5}$ 0.08%	$8.86x10^{-3}$ 16%	$8.95x10^{-3}$ 16%	$3.13x10^{-2}$ 56%
The Derby	$7.32x10^{-3}$ 13%	$4.85x10^{-5}$ 0.08%	$8.86x10^{-3}$ 15%	$8.95x10^{-3}$ 16%	$3.24x10^{-2}$ 56%
The Ankle Boot	$1.24x10^{-2}$ 15%	$8.58x10^{-5}$ 0.10%	$8.86x10^{-3}$ 11%	$1.51x10^{-2}$ 18%	$4.69x10^{-2}$ 56%
The Rockerboot	$1.15x10^{-2}$ 14%	$8.58x10^{-5}$ 0.10%	$8.86x10^{-3}$ 11%	$1.51x10^{-2}$ 18%	$4.69x10^{-2}$ 57%

Table 24. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI - Eutrophication Potential (EP)

EP (kg N eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	4.90×10^{-3} 22%	8.37×10^{-6} 0.04%	2.54×10^{-3} 12%	7.44×10^{-3} 34%	6.92×10^{-3} 32%
The 95 Pump	3.84×10^{-3} 23%	7.85×10^{-6} 0.05%	2.54×10^{-3} 15%	6.27×10^{-3} 38%	3.90×10^{-3} 24%
The Mule	5.22×10^{-3} 28%	1.08×10^{-5} 0.06%	2.54×10^{-3} 14%	6.27×10^{-3} 34%	4.28×10^{-3} 23%
The 95 Slingback	3.08×10^{-3} 20%	4.99×10^{-6} 0.03%	2.54×10^{-3} 16%	6.27×10^{-3} 40%	3.75×10^{-3} 24%
The 75 Slingback	3.17×10^{-3} 20%	5.81×10^{-6} 0.04%	2.54×10^{-3} 16%	6.27×10^{-3} 40%	3.83×10^{-3} 24%
Ballerina	3.01×10^{-3} 20%	7.89×10^{-6} 0.05%	2.54×10^{-3} 16%	6.27×10^{-3} 41%	3.58×10^{-3} 23%
Slingback Flat	3.09×10^{-3} 20%	7.78×10^{-6} 0.05%	2.54×10^{-3} 16%	6.27×10^{-3} 40%	3.77×10^{-3} 24%
The Slipper	4.50×10^{-3} 22%	1.07×10^{-5} 0.05%	3.61×10^{-3} 17%	7.64×10^{-3} 37%	5.15×10^{-3} 25%
The Loafer	4.95×10^{-3} 23%	1.02×10^{-5} 0.05%	3.61×10^{-3} 17%	7.64×10^{-3} 36%	5.09×10^{-3} 24%
The Derby	4.66×10^{-3} 22%	1.17×10^{-5} 0.06%	3.61×10^{-3} 17%	7.64×10^{-3} 36%	5.27×10^{-3} 25%
The Ankle Boot	8.24×10^{-3} 25%	2.08×10^{-5} 0.06%	3.61×10^{-3} 11%	1.28×10^{-2} 40%	7.64×10^{-3} 24%
The Rockerboot	7.39×10^{-3} 23%	2.08×10^{-5} 0.07%	3.61×10^{-3} 11%	1.28×10^{-2} 41%	7.64×10^{-3} 24%

Table 25. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI – Smog Creation Potential (POCP)

POCP (kg O3 eq)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	7.52×10^{-2}	8.13×10^{-4}	5.97×10^{-2}	9.85×10^{-2}	1.02
	6.0%	0.06%	4.7%	7.8%	81%
The 95 Pump	5.66×10^{-2}	7.63×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	0.578
	7.3%	0.10%	7.7%	10%	75%
The Mule	7.46×10^{-2}	1.05×10^{-3}	5.97×10^{-2}	7.82×10^{-2}	0.633
	8.8%	0.12%	7.1%	9.2%	75%
The 95 Slingback	4.37×10^{-2}	4.84×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	0.555
	5.9%	0.07%	8.1%	11%	75%
The 75 Slingback	4.83×10^{-2}	5.64×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	0.567
	6.4%	0.07%	7.9%	10%	75%
Ballerina	4.92×10^{-2}	7.67×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	0.530
	6.9%	0.11%	8.3%	11%	74%
Slingback Flat	5.14×10^{-2}	7.56×10^{-4}	5.97×10^{-2}	7.82×10^{-2}	0.558
	6.9%	0.10%	8.0%	10%	75%
The Slipper	7.03×10^{-2}	1.04×10^{-3}	8.48×10^{-2}	9.71×10^{-2}	0.762
	6.9%	0.10%	8.3%	9.6%	75%
The Loafer	7.09×10^{-2}	9.94×10^{-4}	8.48×10^{-2}	9.71×10^{-2}	0.754
	7.0%	0.10%	8.4%	9.6%	75%
The Derby	7.86×10^{-2}	1.14×10^{-3}	8.48×10^{-2}	9.71×10^{-2}	0.780
	7.5%	0.11%	8.1%	9.3%	75%
The Ankle Boot	0.126	2.02×10^{-3}	8.48×10^{-2}	0.161	1.13
	8.4%	0.13%	5.6%	11%	75%
The Rockerboot	0.118	2.02×10^{-3}	8.48×10^{-2}	0.161	1.13
	7.9%	0.14%	5.7%	11%	76%

Table 26. Contribution Analysis Results for the *AERA* footwear products. Product distribution via air freight. Results are shown for a single pair of shoes. TRACI – Fossil Fuel Depletion (FFD)

FFD (MJ eq.)	Raw Material Extraction	Transport	Manufacturing	Packaging	Distribution
The Platform	3.39	1.65×10^{-2}	3.18	1.94	21.0
	11%	0.06%	11%	6.6%	71%
The 95 Pump	2.18	1.54×10^{-2}	3.18	1.35	11.9
	12%	0.08%	17%	7.3%	64%
The Mule	2.73	2.12×10^{-2}	3.18	1.35	13.0
	13%	0.10%	16%	6.7%	64%
The 95 Slingback	1.55	9.81×10^{-3}	3.18	1.35	11.4
	8.9%	0.06%	18%	7.7%	65%
The 75 Slingback	1.92	1.14×10^{-2}	3.18	1.35	11.6
	11%	0.06%	18%	7.5%	64%
Ballerina	2.17	1.55×10^{-2}	3.18	1.35	10.9
	12%	0.09%	18%	7.7%	62%
Slingback Flat	2.22	1.53×10^{-2}	3.18	1.35	11.5
	12%	0.08%	17%	7.4%	63%
The Slipper	2.92	2.11×10^{-2}	4.51	1.75	15.6
	12%	0.08%	18%	7.0%	63%
The Loafer	2.54	2.01×10^{-2}	4.51	1.75	15.5
	10%	0.08%	19%	7.2%	64%
The Derby	3.47	2.31×10^{-2}	4.51	1.75	16.0
	13%	0.09%	18%	6.8%	62%
The Ankle Boot	5.19	4.09×10^{-2}	4.51	2.84	23.2
	15%	0.11%	13%	7.9%	65%
The Rockerboot	5.05	4.09×10^{-2}	4.51	2.84	23.2
	14%	0.11%	13%	8.0%	65%

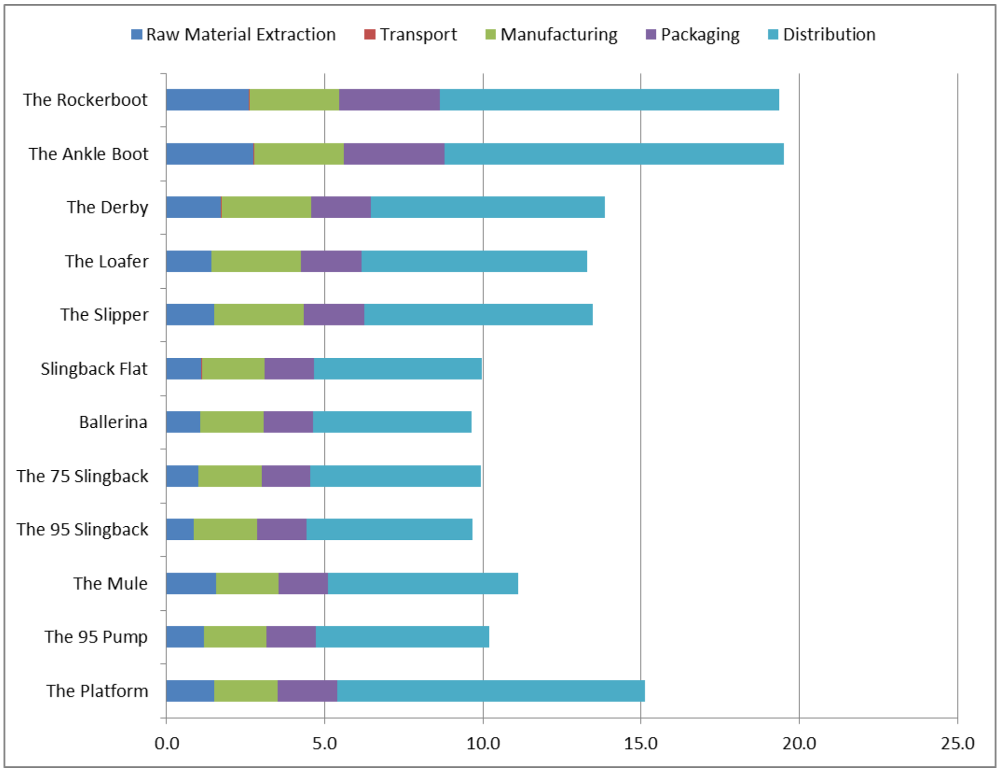

Figure 9. Percent contribution analysis for the *AREA* footwear products. - GWP

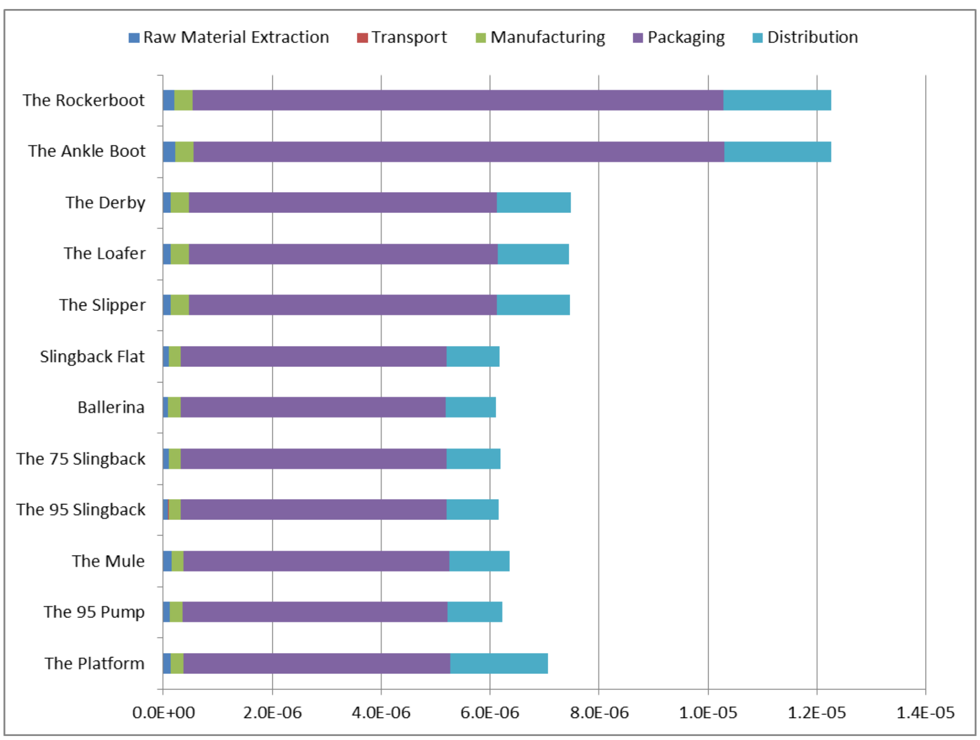

Figure 10. Percent contribution analysis for the *AREA* footwear products. - ODP

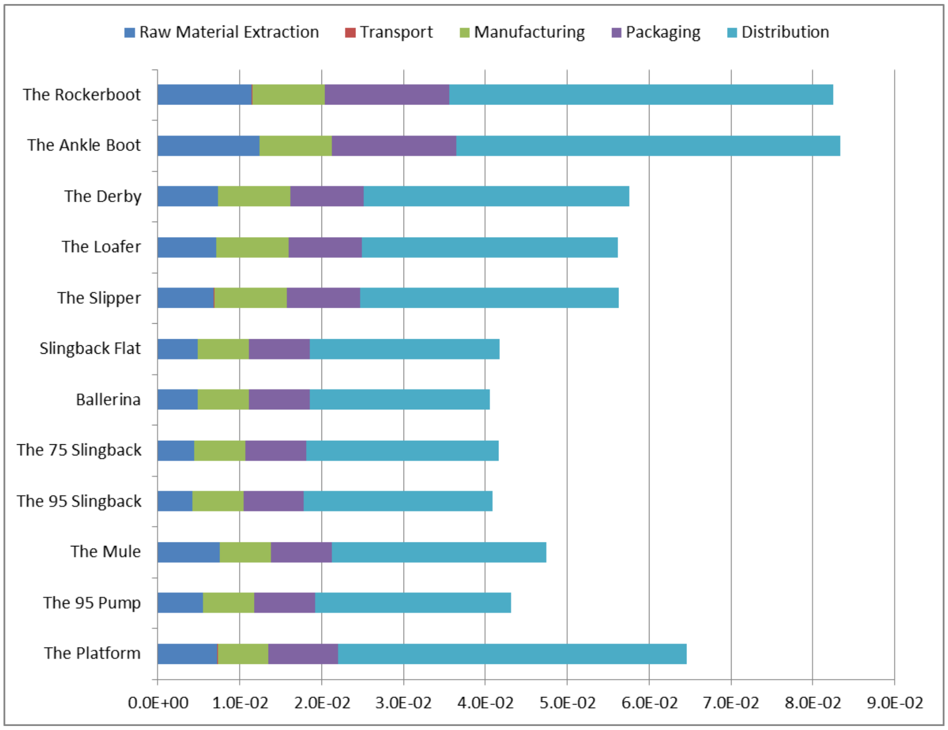

Figure 11. Percent contribution analysis for the *AREA* footwear products. - AP

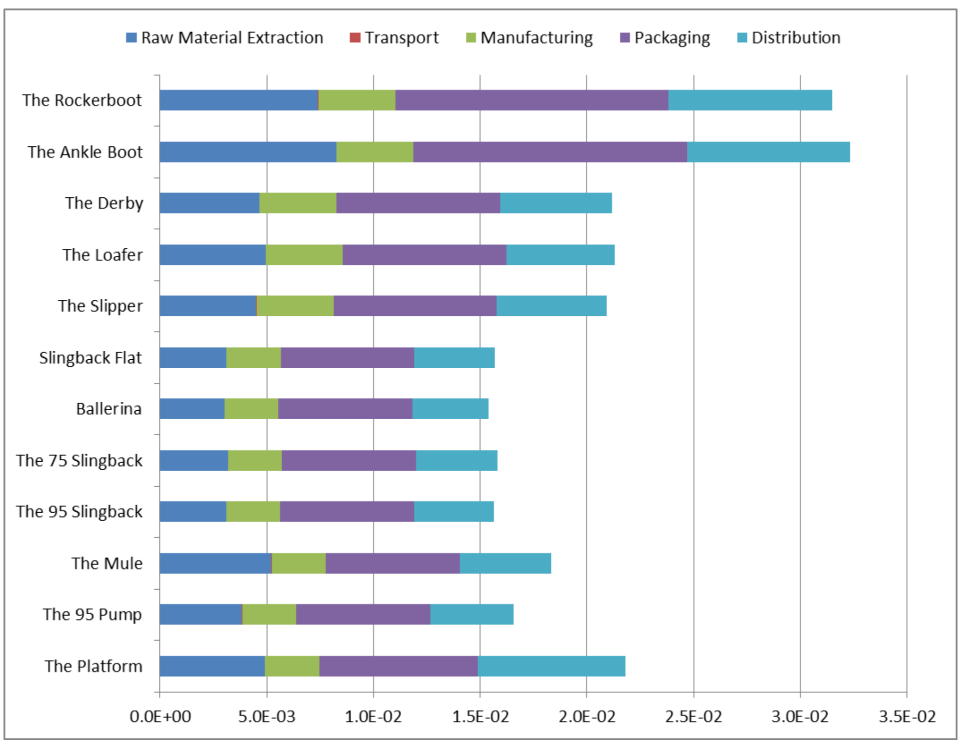

Figure 12. Percent contribution analysis for the *AREA* footwear products. - EP

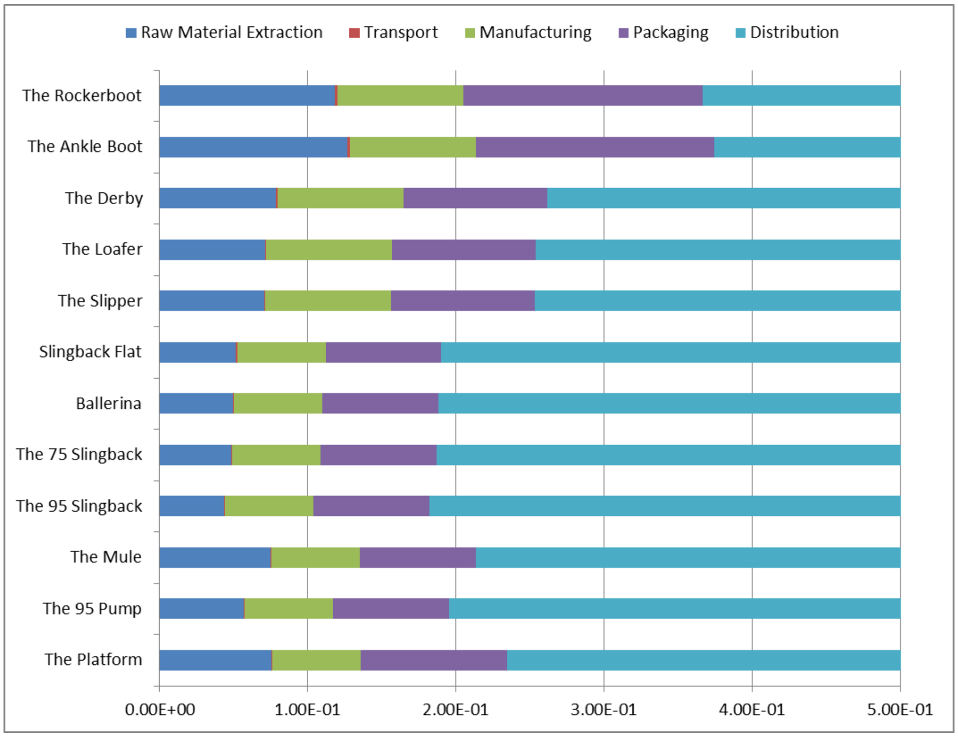

Figure 13. Percent contribution analysis for the *AREA* footwear products. - POCP

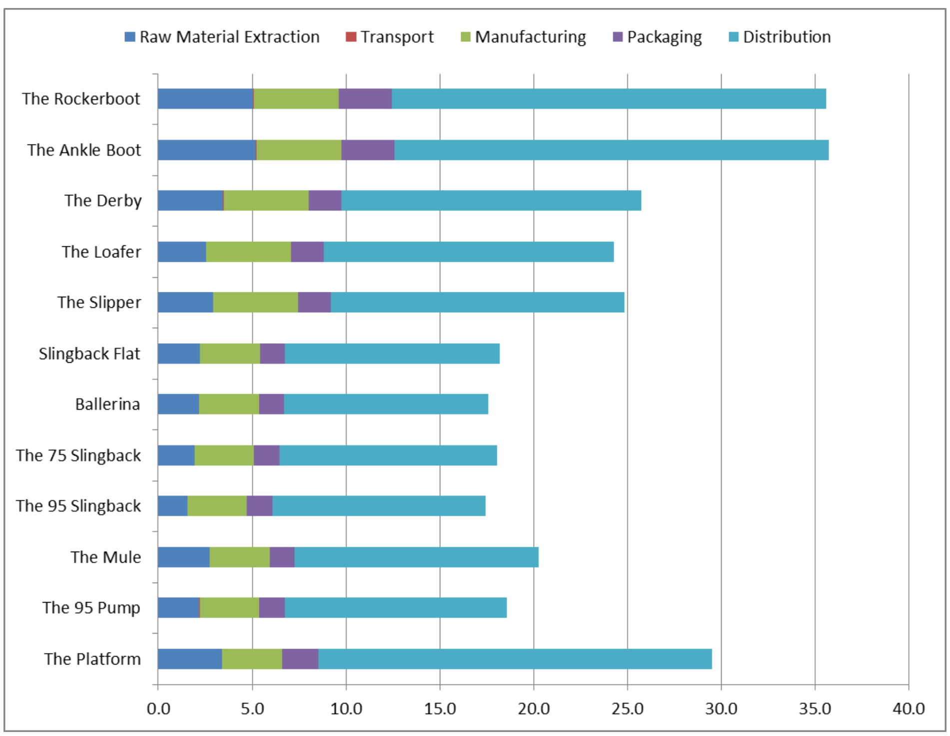

Figure 14. Percent contribution analysis for the *AREA* footwear products. - FFD

4.3 Sensitivity Analyses

Sensitivity analyses are conducted to evaluate the impact of various modeling assumptions on indicator results, including alternative resource allocation approaches. The sensitivity analysis conducted as part of the study is summarized below.

As noted in Section 2.13, approximately 30% of the sold products are assumed to be returned to the manufacturer. To evaluate the effect of the additional transport impacts associated with the returned products, the product system was modeled assuming a 15% product return rate and product distribution via ocean freighter.

The results of the sensitivity modeling are shown in Table 27 below, using the TRACI characterization methodology. Results are presented for the reference flow of one (1) pair of shoes averaged across each of the product lines assessed. Percent differences from the reference scenario are also presented. Only minor decreases in the impact indicator results are estimated with the lower product return rate.

Table 27. TRACI v2.1 Life Cycle Impact Assessment Results for the *AERA* product system model assuming a 15% product return rate. Results are shown for a single product (pair) averaged across products within each style.

Product	GWP kg CO2 eq	ODP kg CFC-11 eq	AP kg SO2 eq	EP kg N eq	POCP kg O3 eq	FFD MJ surplus
The Platform	5.94	$5.37x10^{-6}$	$2.66x10^{-2}$	$1.56x10^{-2}$	0.319	9.67
	-0.90%	-0.19%	-0.93%	-0.39%	-1.8%	-1.2%
The 95 Pump	4.66	$5.22x10^{-6}$	$2.00x10^{-2}$	$1.20x10^{-2}$	0.210	6.68
	-0.41%	-0.07%	-0.44%	-0.18%	-0.97%	-0.62%
The Mule	5.07	$5.26x10^{-6}$	$2.22x10^{-2}$	$1.34x10^{-2}$	0.233	7.30
	-0.43%	-0.08%	-0.45%	-0.18%	-1.0%	-0.66%
The 95 Slingback	4.34	$5.20x10^{-6}$	$1.85x10^{-2}$	$1.12x10^{-2}$	0.195	6.02
	-0.41%	-0.06%	-0.44%	-0.18%	-0.98%	-0.65%
The 75 Slingback	4.48	$5.21x10^{-6}$	$1.89x10^{-2}$	$1.13x10^{-2}$	0.200	6.40
	-0.41%	-0.07%	-0.45%	-0.18%	-0.99%	-0.63%
Ballerina	4.53	$5.19x10^{-6}$	$1.91x10^{-2}$	$1.12x10^{-2}$	0.199	6.61
	-0.36%	-0.06%	-0.40%	-0.16%	-0.89%	-0.54%
Slingback Flat	4.58	$5.20x10^{-6}$	$1.92x10^{-2}$	$1.13x10^{-2}$	0.203	6.70
	-0.39%	-0.06%	-0.43%	-0.18%	-0.95%	-0.59%
The Slipper	6.06	$6.13x10^{-6}$	$2.52x10^{-2}$	$1.47x10^{-2}$	0.264	8.97
	-0.36%	-0.07%	-0.40%	-0.17%	-0.90%	-0.54%
The Loafer	5.98	$6.13x10^{-6}$	$2.55x10^{-2}$	$1.51x10^{-2}$	0.264	8.58
	-0.36%	-0.07%	-0.39%	-0.16%	-0.88%	-0.55%
The Derby	6.30	$6.13x10^{-6}$	$2.58x10^{-2}$	$1.48x10^{-2}$	0.274	9.54
	-0.37%	-0.07%	-0.41%	-0.17%	-0.91%	-0.53%
The Ankle Boot	9.38	$1.04x10^{-5}$	$4.15x10^{-2}$	$2.55x10^{-2}$	0.468	13.9
	-0.63%	-0.11%	-0.66%	-0.26%	-1.4%	-0.94%
The Rockerboot	9.24	$1.04x10^{-5}$	$4.06x10^{-2}$	$2.46x10^{-2}$	0.460	13.7
	-0.64%	-0.11%	-0.67%	-0.27%	-1.4%	-0.95%

GWP - Global Warming Potential
ODP - Ozone Layer Depletion Potential
AP - Acidification Potential
EP - Eutrophication Potential
POCP - Smog Creation Potential
FFD - Fossil Fuel Depletion Potential

5. Life Cycle Interpretation and Recommendations

A life cycle assessment of *The Humble Shoe Company, Inc.'s AERA* footwear products was conducted in conformance with the requirements of ISO 14044 for Life Cycle Assessment and considered the environmental impacts associated with manufacture and distribution of the products. Impact category indicator results for the product system considered are presented in Section 4.

The assessment relied on a number of assumptions and limitations, the most relevant of which are discussed in this report. Most of the upstream raw materials extraction and processing could not be modeled with actual process information. Representative data from Ecoinvent life cycle inventory databases were utilized as appropriate. These datasets were modified to represent the *AERA* product system, when possible.

A contribution analysis was conducted and results summarized by life cycle phase for each style of footwear for a functional unit of one pair of shoes. Results are also evaluated as a percentage of the total for each impact category indicator. For the ocean freight product distribution scenario, depending on the impact category indicator, the main contributions to indicator results, are primarily from the product manufacturing, followed by the product packaging and material extraction and processing. Contributions from product distribution are generally less than 10% of the total impact.

For the air freight distribution scenario, the main contributions to indicator results are primarily from the product distribution, followed by the manufacturing, packaging and material extraction and processing phases.

A sensitivity analysis was conducted to investigate the impacts on estimated indicator results due to assumptions regarding the percentage of products returned to the manufacturer. Only minimal reductions in total estimated impacts are achieved when the assumed rate of product return is reduced from 30% to 15%.

With the exception of the lining and outer material components, much of the analysis relied on secondary data to represent the processing of raw materials for the product components. Due to the significant contribution of this phase, as well as the product packaging, to the product life cycle environmental impacts, primary data for these materials and processes is recommended for inclusion in the assessment. In addition, the use of recycled material for cotton packaging bag should be evaluated for the potential to reduce the overall impacts of the footwear products.

It is noted that the LCIA results presented in this report are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Impact indicators rely on the use of generic models and potential impacts and therefore are not able to measure actual environmental impacts. Additionally, the indicators considered do not represent all categories of potential environmental and human health impacts associated with the life cycle of the *AERA* footwear, and this represents a general limitation of the LCA study.

Appendix A: LCIA Results: Ocean freight distribution scenario – *TRACI*

Table A1. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Platform). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Platform	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Bomber Piton Crom Platino	6.11	$5.38x10^{-6}$	$2.74x10^{-2}$	$1.61x10^{-2}$	0.332	10.0
Tessuto Notturno	5.88	$5.37x10^{-6}$	$2.63x10^{-2}$	$1.52x10^{-2}$	0.318	9.58

Table A2. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Pump). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 95 Pump	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	4.93	$5.26x10^{-6}$	$2.11x10^{-2}$	$1.24x10^{-2}$	0.239	7.23
Premiere Must Lux 100 Cammeo	5.41	$5.29x10^{-6}$	$2.31x10^{-2}$	$1.37x10^{-2}$	0.262	8.24
Ctd. Tender Ac-Drill Nero	5.07	$5.29x10^{-6}$	$2.24x10^{-2}$	$1.37x10^{-2}$	0.250	7.30
Ctd. Grand Pythonss	4.87	$5.26x10^{-6}$	$2.09x10^{-2}$	$1.24x10^{-2}$	0.236	7.15
Tessuto Notturno	5.01	$5.28x10^{-6}$	$2.20x10^{-2}$	$1.32x10^{-2}$	0.246	7.26

Table A3. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Mule). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values

TRACI The Mule	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Tender Ac-Drill Navy	5.59	$5.33x10^{-6}$	$2.51x10^{-2}$	$1.52x10^{-2}$	0.278	8.14
Ctd. Tender Ac-Drill Nero	5.59	$5.33x10^{-6}$	$2.51x10^{-2}$	$1.52x10^{-2}$	0.278	8.14
Ctd. Grand Pythonss	5.25	$5.29x10^{-6}$	$2.25x10^{-2}$	$1.31x10^{-2}$	0.254	7.90

Table A4. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 95 Slingback	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	4.66	$5.24x10^{-6}$	$1.98x10^{-2}$	$1.18x10^{-2}$	0.226	6.69
Ctd. Bomber Piton Crom Platino	4.80	$5.26x10^{-6}$	$2.07x10^{-2}$	$1.25x10^{-2}$	0.235	6.92
Ctd. Tender Ac-Drill Nero	4.76	$5.26x10^{-6}$	$2.08x10^{-2}$	$1.27x10^{-2}$	0.234	6.75
Tessuto Notturno	4.71	$5.26x10^{-6}$	$2.05x10^{-2}$	$1.23x10^{-2}$	0.231	6.71

Table A5. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 75 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 75 Slingback	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	4.65	5.24×10^{-6}	1.98×10^{-2}	1.17×10^{-2}	0.226	6.69
Premiere Must Lux 100 Cammeo	4.99	5.26×10^{-6}	2.12×10^{-2}	1.26×10^{-2}	0.242	7.41
Premiere Must Lux 100 Hortensia	4.99	5.26×10^{-6}	2.12×10^{-2}	1.26×10^{-2}	0.242	7.41
Premiere Must Lux 100 Nera	4.99	5.26×10^{-6}	2.12×10^{-2}	1.26×10^{-2}	0.242	7.41
Premiere Must Lux 100 Bianco	4.99	5.26×10^{-6}	2.12×10^{-2}	1.26×10^{-2}	0.242	7.41
Ctd Specchio Crom Extra 85 Argento 1	4.90	5.26×10^{-6}	2.11×10^{-2}	1.26×10^{-2}	0.239	7.14
Ctd Specchio Crom Extra 85 Jute	4.90	5.26×10^{-6}	2.11×10^{-2}	1.26×10^{-2}	0.239	7.14
Ctd. Grand Pythonss	4.61	5.24×10^{-6}	1.97×10^{-2}	1.18×10^{-2}	0.224	6.64

Table A6. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (Ballerina). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI Ballerina	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Bomber Piton Crom Argento	5.02	5.25×10^{-6}	2.15×10^{-2}	1.26×10^{-2}	0.240	7.50
Ctd. Bomber Piton Crom Platino	5.02	5.25×10^{-6}	2.15×10^{-2}	1.26×10^{-2}	0.240	7.50
Ctd. Grand Pythonss	4.74	5.23×10^{-6}	2.01×10^{-2}	1.15×10^{-2}	0.224	7.09

Table A7. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (Slingback Flat). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI Slingback Flat	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	4.71	5.24×10^{-6}	2.00×10^{-2}	1.16×10^{-2}	0.227	6.88
Premiere Must Lux 100 Cammeo	5.08	5.26×10^{-6}	2.16×10^{-2}	1.26×10^{-2}	0.245	7.66
Premiere Must Lux 100 Hortensia	5.08	5.26×10^{-6}	2.16×10^{-2}	1.26×10^{-2}	0.245	7.66
Premiere Must Lux 100 Nera	5.05	5.26×10^{-6}	2.14×10^{-2}	1.25×10^{-2}	0.243	7.60

Table A8. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Slipper). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Slipper	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	7.01	6.22×10^{-6}	2.92×10^{-2}	1.67×10^{-2}	0.335	10.9
Ctd. Tender Ac-Drill Nero	6.59	6.21×10^{-6}	2.85×10^{-2}	1.68×10^{-2}	0.321	9.76
Ctd. Grand Pythonss	6.69	6.21×10^{-6}	2.79×10^{-2}	1.60×10^{-2}	0.319	10.4
Tessuto Notturno	6.41	6.20×10^{-6}	2.74×10^{-2}	1.58×10^{-2}	0.309	9.52

Table A9. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Loafer). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Loafer	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Tender Ac-Drill Navy	6.59	6.21×10^{-6}	2.85×10^{-2}	1.68×10^{-2}	0.321	9.76
Ctd. Tender Ac-Drill Beige	6.59	6.21×10^{-6}	2.85×10^{-2}	1.68×10^{-2}	0.321	9.76

Table A10. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Derby). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Derby	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	7.01	6.22×10^{-6}	2.92×10^{-2}	1.67×10^{-2}	0.335	10.9
Premiere Must Vitello 85	6.82	6.20×10^{-6}	2.85×10^{-2}	1.63×10^{-2}	0.326	10.5

Table A11. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Ankle Boot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Ankle Boot	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	9.99	1.04×10^{-5}	4.32×10^{-2}	2.59×10^{-2}	0.497	15.3
Ctd. Tender Ac-Drill Navy	9.14	1.04×10^{-5}	4.17×10^{-2}	2.60×10^{-2}	0.468	13.0
Ctd. Tender Ac-Drill Beige	9.14	1.04×10^{-5}	4.17×10^{-2}	2.60×10^{-2}	0.468	13.0
Ctd. Grand Pythonss	9.35	1.04×10^{-5}	4.06×10^{-2}	2.46×10^{-2}	0.464	14.2
Premiere Must Vitello 85	9.60	1.04×10^{-5}	4.17×10^{-2}	2.51×10^{-2}	0.479	14.5

Table A12. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Rockerboot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Rockerboot	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Tessuto Notturno	8.84	1.04×10^{-5}	3.98×10^{-2}	2.42×10^{-2}	0.449	12.6
Ctd. Grand Pythonss	9.40	1.04×10^{-5}	4.09×10^{-2}	2.47×10^{-2}	0.468	14.3
Premiere Must Vitello 85	9.65	1.04×10^{-5}	4.20×10^{-2}	2.52×10^{-2}	0.483	14.6

Appendix B: LCIA Results: Ocean freight distribution scenario – *CML*

Table B1. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Platform). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Platform	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Bomber Piton Crom Platino	6.21	$5.38x10^{-6}$	$2.72x10^{-2}$	$8.50x10^{-3}$	$1.37x10^{-3}$	$7.72x10^{-5}$	86.7
Tessuto Notturno	5.98	$5.38x10^{-6}$	$2.61x10^{-2}$	$8.05x10^{-3}$	$1.31x10^{-3}$	$1.13x10^{-5}$	83.2

Table B2. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Pump). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 95 Pump	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	5.01	$5.26x10^{-6}$	$2.12x10^{-2}$	$6.50x10^{-3}$	$1.06x10^{-3}$	$1.04x10^{-5}$	65.4
Premiere Must Lux 100 Cammeo	5.51	$5.29x10^{-6}$	$2.31x10^{-2}$	$7.09x10^{-3}$	$1.18x10^{-3}$	$1.04x10^{-5}$	73.3
Ctd. Tender Ac-Drill Nero	5.16	$5.29x10^{-6}$	$2.24x10^{-2}$	$7.15x10^{-3}$	$1.10x10^{-3}$	$1.04x10^{-5}$	66.5
Ctd. Grand Pythonss	4.95	$5.26x10^{-6}$	$2.10x10^{-2}$	$6.47x10^{-3}$	$1.05x10^{-3}$	$9.78x10^{-6}$	64.9
Tessuto Notturno	5.10	$5.28x10^{-6}$	$2.20x10^{-2}$	$6.90x10^{-3}$	$1.09x10^{-3}$	$9.97x10^{-6}$	66.0

Table B3. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Mule). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Mule	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Tender Ac-Drill Navy	5.69	$5.33x10^{-6}$	$2.50x10^{-2}$	$7.97x10^{-3}$	$1.22x10^{-3}$	$1.04x10^{-5}$	73.4
Ctd. Tender Ac-Drill Nero	5.69	$5.33x10^{-6}$	$2.50x10^{-2}$	$7.97x10^{-3}$	$1.22x10^{-3}$	$1.04x10^{-5}$	73.4
Ctd. Grand Pythonss	5.34	$5.29x10^{-6}$	$2.26x10^{-2}$	$6.82x10^{-3}$	$1.14x10^{-3}$	$9.38x10^{-6}$	70.8

Table B4. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 95 Slingback	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	4.73	$5.24x10^{-6}$	$1.99x10^{-2}$	$6.15x10^{-3}$	$9.89x10^{-4}$	$9.18x10^{-6}$	61.1
Ctd. Bomber Piton Crom Platino	4.88	$5.26x10^{-6}$	$2.07x10^{-2}$	$6.51x10^{-3}$	$1.03x10^{-3}$	$9.05x10^{-6}$	63.1
Ctd. Tender Ac-Drill Nero	4.84	$5.26x10^{-6}$	$2.08x10^{-2}$	$6.62x10^{-3}$	$1.02x10^{-3}$	$9.17x10^{-6}$	61.9
Tessuto Notturno	4.79	$5.26x10^{-6}$	$2.05x10^{-2}$	$6.43x10^{-3}$	$1.01x10^{-3}$	$8.87x10^{-6}$	61.5

Table B5. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 75 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 75 Slingback	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	4.73	$5.24x10^{-6}$	$1.99x10^{-2}$	$6.14x10^{-3}$	$9.87x10^{-4}$	$9.12x10^{-6}$	61.1
Premiere Must Lux 100 Cammeo	5.08	$5.26x10^{-6}$	$2.13x10^{-2}$	$6.56x10^{-3}$	$1.07x10^{-3}$	$9.10x10^{-6}$	66.7
Premiere Must Lux 100 Hortensia	5.08	$5.26x10^{-6}$	$2.13x10^{-2}$	$6.56x10^{-3}$	$1.07x10^{-3}$	$9.10x10^{-6}$	66.7
Premiere Must Lux 100 Nera	5.08	$5.26x10^{-6}$	$2.13x10^{-2}$	$6.56x10^{-3}$	$1.07x10^{-3}$	$9.10x10^{-6}$	66.7
Premiere Must Lux 100 Bianco	5.08	$5.26x10^{-6}$	$2.13x10^{-2}$	$6.56x10^{-3}$	$1.07x10^{-3}$	$9.10x10^{-6}$	66.7
Ctd Specchio Crom Extra 85 Argento 1	4.99	$5.26x10^{-6}$	$2.11x10^{-2}$	$6.58x10^{-3}$	$1.05x10^{-3}$	$9.02x10^{-6}$	64.7
Ctd Specchio Crom Extra 85 Jute	4.99	$5.26x10^{-6}$	$2.11x10^{-2}$	$6.59x10^{-3}$	$1.05x10^{-3}$	$9.02x10^{-6}$	64.7
Ctd. Grand Pythonss	4.68	$5.25x10^{-6}$	$1.97x10^{-2}$	$6.12x10^{-3}$	$9.82x10^{-4}$	$8.68x10^{-6}$	60.8

Table B6. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (Ballerina). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML Ballerina	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Bomber Piton Crom Argento	5.11	5.25×10^{-6}	2.16×10^{-2}	6.58×10^{-3}	1.05×10^{-3}	8.90×10^{-6}	67.0
Ctd. Bomber Piton Crom Platino	5.11	5.25×10^{-6}	2.16×10^{-2}	6.58×10^{-3}	1.05×10^{-3}	8.90×10^{-6}	67.0
Ctd. Grand Pythonss	4.82	5.23×10^{-6}	2.02×10^{-2}	6.03×10^{-3}	9.85×10^{-4}	8.45×10^{-6}	63.5

Table B7. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (Slingback Flat). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML Slingback Flat	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	4.78	5.24×10^{-6}	2.01×10^{-2}	6.10×10^{-3}	9.91×10^{-4}	9.03×10^{-6}	62.2
Premiere Must Lux 100 Cammeo	5.17	5.26×10^{-6}	2.16×10^{-2}	6.56×10^{-3}	1.08×10^{-3}	9.03×10^{-6}	68.3
Premiere Must Lux 100 Hortensia	5.17	5.26×10^{-6}	2.16×10^{-2}	6.56×10^{-3}	1.08×10^{-3}	9.03×10^{-6}	68.3
Premiere Must Lux 100 Nera	5.14	5.26×10^{-6}	2.15×10^{-2}	6.52×10^{-3}	1.08×10^{-3}	8.99×10^{-6}	67.8

Table B8. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Slipper). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Slipper	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	7.14	6.22×10^{-6}	2.94×10^{-2}	8.73×10^{-3}	1.49×10^{-3}	1.20×10^{-5}	95.9
Ctd. Tender Ac-Drill Nero	6.71	6.21×10^{-6}	2.84×10^{-2}	8.82×10^{-3}	1.40×10^{-3}	1.20×10^{-5}	87.4
Ctd. Grand Pythonss	6.81	6.21×10^{-6}	2.81×10^{-2}	8.37×10^{-3}	1.43×10^{-3}	1.21×10^{-5}	91.7
Tessuto Notturno	6.53	6.20×10^{-6}	2.74×10^{-2}	8.30×10^{-3}	1.35×10^{-3}	1.12×10^{-5}	85.3

Table 9. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Loafer). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Loafer	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Tender Ac-Drill Navy	6.71	6.21×10^{-6}	2.84×10^{-2}	8.82×10^{-3}	1.40×10^{-3}	1.20×10^{-5}	87.4
Ctd. Tender Ac-Drill Beige	6.71	6.21×10^{-6}	2.84×10^{-2}	8.82×10^{-3}	1.40×10^{-3}	1.20×10^{-5}	87.4

Table B10. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Derby). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Derby	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	7.14	6.22×10^{-6}	2.94×10^{-2}	8.73×10^{-3}	1.49×10^{-3}	1.20×10^{-5}	95.9
Premiere Must Vitello 85	6.94	6.20×10^{-6}	2.86×10^{-2}	8.51×10^{-3}	1.45×10^{-3}	1.16×10^{-5}	92.6

Table B11. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Ankle Boot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Ankle Boot	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	10.2	1.04×10^{-5}	4.33×10^{-2}	1.34×10^{-2}	2.20×10^{-3}	4.95×10^{-5}	135
Ctd. Tender Ac-Drill Navy	9.30	1.04×10^{-5}	4.14×10^{-2}	1.36×10^{-2}	2.00×10^{-3}	4.95×10^{-5}	118
Ctd. Tender Ac-Drill Beige	9.30	1.04×10^{-5}	4.14×10^{-2}	1.36×10^{-2}	2.00×10^{-3}	4.95×10^{-5}	118
Ctd. Grand Pythonss	9.51	1.04×10^{-5}	4.06×10^{-2}	1.27×10^{-2}	2.06×10^{-3}	4.97×10^{-5}	127
Premiere Must Vitello 85	9.78	1.04×10^{-5}	4.18×10^{-2}	1.30×10^{-2}	2.10×10^{-3}	4.87×10^{-5}	129

Table B12. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Rockerboot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Rockerboot	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Tessuto Notturno	8.99	1.04×10^{-5}	3.97×10^{-2}	1.26×10^{-2}	1.94×10^{-3}	4.82×10^{-5}	115
Ctd. Grand Pythonss	9.56	1.04×10^{-5}	4.09×10^{-2}	1.28×10^{-2}	2.09×10^{-3}	4.98×10^{-5}	128
Premiere Must Vitello 85	9.83	1.04×10^{-5}	4.21×10^{-2}	1.31×10^{-2}	2.12×10^{-3}	4.89×10^{-5}	130

Appendix C: LCIA Results: Air freight distribution scenario – *TRACI*

Table C1. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Platform). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Platform	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Bomber Piton Crom Platino	15.3	7.08×10^{-6}	6.55×10^{-2}	2.24×10^{-2}	1.28	30.0
Tessuto Notturno	14.9	7.04×10^{-6}	6.36×10^{-2}	2.13×10^{-2}	1.24	29.1

Table C2. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Pump). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 95 Pump	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	9.93	6.18×10^{-6}	4.17×10^{-2}	1.58×10^{-2}	0.750	18.0
Premiere Must Lux 100 Cammeo	10.9	6.29×10^{-6}	4.56×10^{-2}	1.73×10^{-2}	0.820	20.0
Ctd. Tender Ac-Drill Nero	10.3	6.24×10^{-6}	4.38×10^{-2}	1.72×10^{-2}	0.780	18.5
Ctd. Grand Pythonss	9.85	6.18×10^{-6}	4.15×10^{-2}	1.58×10^{-2}	0.745	17.9
Tessuto Notturno	10.1	6.22×10^{-6}	4.32×10^{-2}	1.67×10^{-2}	0.770	18.3

Table C3. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Mule). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values

TRACI The Mule	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Tender Ac-Drill Navy	11.3	6.38×10^{-6}	4.88×10^{-2}	1.91×10^{-2}	0.866	20.6
Ctd. Tender Ac-Drill Nero	11.3	6.38×10^{-6}	4.88×10^{-2}	1.91×10^{-2}	0.866	20.6
Ctd. Grand Pythonss	10.7	6.29×10^{-6}	4.49×10^{-2}	1.68×10^{-2}	0.808	19.6

Table C4. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 95 Slingback	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	9.50	6.14×10^{-6}	3.99×10^{-2}	1.50×10^{-2}	0.722	17.2
Ctd. Bomber Piton Crom Platino	9.80	6.18×10^{-6}	4.14×10^{-2}	1.59×10^{-2}	0.747	17.8
Ctd. Tender Ac-Drill Nero	9.74	6.18×10^{-6}	4.14×10^{-2}	1.60×10^{-2}	0.744	17.5
Tessuto Notturno	9.65	6.17×10^{-6}	4.09×10^{-2}	1.56×10^{-2}	0.736	17.4

Table C5. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The 75 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The 75 Slingback	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	9.48	6.13×10^{-6}	3.98×10^{-2}	1.50×10^{-2}	0.720	17.1
Premiere Must Lux 100 Cammeo	10.1	6.21×10^{-6}	4.25×10^{-2}	1.61×10^{-2}	0.769	18.6
Premiere Must Lux 100 Hortensia	10.1	6.21×10^{-6}	4.25×10^{-2}	1.61×10^{-2}	0.769	18.6
Premiere Must Lux 100 Nera	10.1	6.21×10^{-6}	4.25×10^{-2}	1.61×10^{-2}	0.769	18.6
Premiere Must Lux 100 Bianco	10.1	6.21×10^{-6}	4.25×10^{-2}	1.61×10^{-2}	0.769	18.6
Ctd Specchio Crom Extra 85 Argento 1	9.97	6.19×10^{-6}	4.20×10^{-2}	1.60×10^{-2}	0.757	18.1
Ctd Specchio Crom Extra 85 Jute	9.97	6.19×10^{-6}	4.20×10^{-2}	1.61×10^{-2}	0.757	18.1
Ctd. Grand Pythonss	9.43	6.13×10^{-6}	3.96×10^{-2}	1.50×10^{-2}	0.717	17.1

Table C6. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (Ballerina). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI Ballerina	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Bomber Piton Crom Argento	9.82	6.13×10^{-6}	4.13×10^{-2}	1.58×10^{-2}	0.731	17.9
Ctd. Bomber Piton Crom Platino	9.82	6.13×10^{-6}	4.13×10^{-2}	1.58×10^{-2}	0.731	17.9
Ctd. Grand Pythonss	9.30	6.07×10^{-6}	3.89×10^{-2}	1.46×10^{-2}	0.690	16.9

Table C7. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (Slingback Flat). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI Slingback Flat	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Patchsnake Ss	9.42	6.11×10^{-6}	3.95×10^{-2}	1.48×10^{-2}	0.709	17.1
Premiere Must Lux 100 Cammeo	10.1	6.19×10^{-6}	4.25×10^{-2}	1.60×10^{-2}	0.763	18.6
Premiere Must Lux 100 Hortensia	10.1	6.19×10^{-6}	4.25×10^{-2}	1.60×10^{-2}	0.763	18.6
Premiere Must Lux 100 Nera	10.1	6.19×10^{-6}	4.22×10^{-2}	1.59×10^{-2}	0.758	18.5

Table C8. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Slipper). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Slipper	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	14.1	7.51×10^{-6}	5.84×10^{-2}	2.15×10^{-2}	1.06	26.2
Ctd. Tender Ac-Drill Nero	13.3	7.45×10^{-6}	5.62×10^{-2}	2.13×10^{-2}	1.01	24.3
Ctd. Grand Pythonss	13.6	7.47×10^{-6}	5.63×10^{-2}	2.07×10^{-2}	1.02	25.2
Tessuto Notturno	12.9	7.40×10^{-6}	5.43×10^{-2}	2.02×10^{-2}	0.976	23.6

Table C9. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Loafer). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Loafer	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Ctd. Tender Ac-Drill Navy	13.3	7.45×10^{-6}	5.62×10^{-2}	2.13×10^{-2}	1.01	24.3
Ctd. Tender Ac-Drill Beige	13.3	7.45×10^{-6}	5.62×10^{-2}	2.13×10^{-2}	1.01	24.3

Table C10. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Derby). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Derby	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	14.1	7.51×10^{-6}	5.84×10^{-2}	2.15×10^{-2}	1.06	26.2
Premiere Must Vitello 85	13.7	7.46×10^{-6}	5.68×10^{-2}	2.09×10^{-2}	1.03	25.3

Table C11. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Ankle Boot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Ankle Boot	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Premiere Must Lux 100 Nera	20.5	1.24×10^{-5}	8.65×10^{-2}	3.30×10^{-2}	1.57	38.0
Ctd. Tender Ac-Drill Navy	19.0	1.22×10^{-5}	8.22×10^{-2}	3.27×10^{-2}	1.47	34.2
Ctd. Tender Ac-Drill Beige	19.0	1.22×10^{-5}	8.22×10^{-2}	3.27×10^{-2}	1.47	34.2
Ctd. Grand Pythonss	19.5	1.23×10^{-5}	8.24×10^{-2}	3.14×10^{-2}	1.50	36.1
Premiere Must Vitello 85	19.7	1.23×10^{-5}	8.33×10^{-2}	3.19×10^{-2}	1.51	36.3

Table C12. TRACI Life Cycle Impact Assessment Results for the *AERA* footwear products (The Rockerboot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

TRACI The Rockerboot	GWP (kg CO2 eq)	ODP (kg CFC-11 eq)	AP (kg SO2 eq)	EP (kg N eq)	POCP (kg O3 eq)	FFD (MJ eq.)
Tessuto Notturno	18.5	1.22×10^{-5}	7.96×10^{-2}	3.07×10^{-2}	1.43	33.4
Ctd. Grand Pythonss	19.7	1.23×10^{-5}	8.34×10^{-2}	3.16×10^{-2}	1.52	36.6
Premiere Must Vitello 85	19.9	1.23×10^{-5}	8.44×10^{-2}	3.21×10^{-2}	1.53	36.8

Appendix D: LCIA Results: Air freight distribution scenario – *CML*

Table D1. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Platform). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Platform	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Bomber Piton Crom Platino	15.5	7.08×10^{-6}	6.00×10^{-2}	1.48×10^{-2}	2.80×10^{-3}	7.81×10^{-5}	227
Tessuto Notturno	15.0	7.04×10^{-6}	5.81×10^{-2}	1.42×10^{-2}	2.71×10^{-3}	1.22×10^{-5}	221

Table D2. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Pump). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 95 Pump	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	10.0	6.18×10^{-6}	3.89×10^{-2}	9.91×10^{-3}	1.83×10^{-3}	1.09×10^{-5}	142
Premiere Must Lux 100 Cammeo	11.0	6.29×10^{-6}	4.25×10^{-2}	1.08×10^{-2}	2.02×10^{-3}	1.09×10^{-5}	156
Ctd. Tender Ac-Drill Nero	10.4	6.24×10^{-6}	4.08×10^{-2}	1.07×10^{-2}	1.90×10^{-3}	1.09×10^{-5}	146
Ctd. Grand Pythonss	9.94	6.18×10^{-6}	3.87×10^{-2}	9.86×10^{-3}	1.82×10^{-3}	1.03×10^{-5}	141
Tessuto Notturno	10.2	6.22×10^{-6}	4.02×10^{-2}	1.04×10^{-2}	1.88×10^{-3}	1.05×10^{-5}	144

Table D3. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Mule). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Mule	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Tender Ac-Drill Navy	11.5	6.39×10^{-6}	4.54×10^{-2}	1.19×10^{-2}	2.11×10^{-3}	1.09×10^{-5}	161
Ctd. Tender Ac-Drill Nero	11.5	6.39×10^{-6}	4.54×10^{-2}	1.19×10^{-2}	2.11×10^{-3}	1.09×10^{-5}	161
Ctd. Grand Pythonss	10.8	6.29×10^{-6}	4.18×10^{-2}	1.05×10^{-2}	1.98×10^{-3}	9.90×10^{-6}	153

Table D4. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 95 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 95 Slingback	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	9.59	6.14×10^{-6}	3.71×10^{-2}	9.45×10^{-3}	1.74×10^{-3}	9.65×10^{-6}	135
Ctd. Bomber Piton Crom Platino	9.90	6.18×10^{-6}	3.85×10^{-2}	9.92×10^{-3}	1.80×10^{-3}	9.54×10^{-6}	139
Ctd. Tender Ac-Drill Nero	9.83	6.18×10^{-6}	3.84×10^{-2}	1.00×10^{-2}	1.79×10^{-3}	9.65×10^{-6}	138
Tessuto Notturno	9.74	6.17×10^{-6}	3.80×10^{-2}	9.79×10^{-3}	1.77×10^{-3}	9.35×10^{-6}	137

Table D5. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The 75 Slingback). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The 75 Slingback	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	9.57	6.13×10^{-6}	3.70×10^{-2}	9.43×10^{-3}	1.73×10^{-3}	9.58×10^{-6}	135
Premiere Must Lux 100 Cammeo	10.2	6.21×10^{-6}	3.96×10^{-2}	1.01×10^{-2}	1.87×10^{-3}	9.60×10^{-6}	145
Premiere Must Lux 100 Hortensia	10.2	6.21×10^{-6}	3.96×10^{-2}	1.01×10^{-2}	1.87×10^{-3}	9.60×10^{-6}	145
Premiere Must Lux 100 Nera	10.2	6.21×10^{-6}	3.96×10^{-2}	1.01×10^{-2}	1.87×10^{-3}	9.60×10^{-6}	145
Premiere Must Lux 100 Bianco	10.2	6.21×10^{-6}	3.96×10^{-2}	1.01×10^{-2}	1.87×10^{-3}	9.60×10^{-6}	145
Ctd Specchio Crom Extra 85 Argento 1	10.1	6.19×10^{-6}	3.91×10^{-2}	1.00×10^{-2}	1.83×10^{-3}	9.51×10^{-6}	142
Ctd Specchio Crom Extra 85 Jute	10.1	6.19×10^{-6}	3.91×10^{-2}	1.00×10^{-2}	1.83×10^{-3}	9.51×10^{-6}	142
Ctd. Grand Pythonss	9.52	6.13×10^{-6}	3.69×10^{-2}	9.40×10^{-3}	1.73×10^{-3}	9.15×10^{-6}	134

Table D6. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (Ballerina). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML Ballerina	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Bomber Piton Crom Argento	9.92	6.13×10^{-6}	3.86×10^{-2}	9.84×10^{-3}	1.79×10^{-3}	9.37×10^{-6}	140
Ctd. Bomber Piton Crom Platino	9.92	6.13×10^{-6}	3.86×10^{-2}	9.84×10^{-3}	1.79×10^{-3}	9.37×10^{-6}	140
Ctd. Grand Pythonss	9.39	6.07×10^{-6}	3.63×10^{-2}	9.13×10^{-3}	1.69×10^{-3}	8.89×10^{-6}	133

Table D7. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (Slingback Flat). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML Slingback Flat	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Patchsnake Ss	9.51	6.11×10^{-6}	3.68×10^{-2}	9.31×10^{-3}	1.72×10^{-3}	9.49×10^{-6}	134
Premiere Must Lux 100 Cammeo	10.3	6.20×10^{-6}	3.96×10^{-2}	1.00×10^{-2}	1.87×10^{-3}	9.52×10^{-6}	146
Premiere Must Lux 100 Hortensia	10.3	6.20×10^{-6}	3.96×10^{-2}	1.00×10^{-2}	1.87×10^{-3}	9.52×10^{-6}	146
Premiere Must Lux 100 Nera	10.2	6.19×10^{-6}	3.94×10^{-2}	9.95×10^{-3}	1.86×10^{-3}	9.48×10^{-6}	145

Table D8. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Slipper). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Slipper	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	14.2	7.51×10^{-6}	5.44×10^{-2}	1.35×10^{-2}	2.59×10^{-3}	1.27×10^{-5}	203
Ctd. Tender Ac-Drill Nero	13.4	7.45×10^{-6}	5.23×10^{-2}	1.34×10^{-2}	2.43×10^{-3}	1.26×10^{-5}	190
Ctd. Grand Pythonss	13.7	7.47×10^{-6}	5.24×10^{-2}	1.30×10^{-2}	2.49×10^{-3}	1.27×10^{-5}	196
Tessuto Notturno	13.1	7.40×10^{-6}	5.06×10^{-2}	1.27×10^{-2}	2.36×10^{-3}	1.19×10^{-5}	185

Table 9. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Loafer). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Loafer	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Ctd. Tender Ac-Drill Navy	13.4	7.45×10^{-6}	5.23×10^{-2}	1.34×10^{-2}	2.43×10^{-3}	1.26×10^{-5}	190
Ctd. Tender Ac-Drill Beige	13.4	7.45×10^{-6}	5.23×10^{-2}	1.34×10^{-2}	2.43×10^{-3}	1.26×10^{-5}	190

Table D10. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Derby). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Derby	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	14.2	7.51×10^{-6}	5.44×10^{-2}	1.35×10^{-2}	2.59×10^{-3}	1.27×10^{-5}	203
Premiere Must Vitello 85	13.8	7.46×10^{-6}	5.29×10^{-2}	1.32×10^{-2}	2.51×10^{-3}	1.22×10^{-5}	197

Table D11. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Ankle Boot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Ankle Boot	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Premiere Must Lux 100 Nera	20.7	1.24×10^{-5}	8.05×10^{-2}	2.06×10^{-2}	3.82×10^{-3}	5.05×10^{-5}	296
Ctd. Tender Ac-Drill Navy	19.1	1.22×10^{-5}	7.63×10^{-2}	2.03×10^{-2}	3.52×10^{-3}	5.04×10^{-5}	268
Ctd. Tender Ac-Drill Beige	19.1	1.22×10^{-5}	7.63×10^{-2}	2.03×10^{-2}	3.52×10^{-3}	5.04×10^{-5}	268
Ctd. Grand Pythonss	19.7	1.23×10^{-5}	7.66×10^{-2}	1.96×10^{-2}	3.63×10^{-3}	5.07×10^{-5}	282
Premiere Must Vitello 85	19.9	1.23×10^{-5}	7.76×10^{-2}	1.99×10^{-2}	3.66×10^{-3}	4.97×10^{-5}	283

Table D12. CML-IA Life Cycle Impact Assessment Results for the *AERA* footwear products (The Rockerboot). Results are shown for a single pair of shoes. Results reported in MJ are calculated using lower heating values.

CML The Rockerboot	GWP (kg CO_2 eq)	ODP (kg CFC-11 eq)	AP (kg SO_2 eq)	EP (kg $(PO_4)^{3-}$ eq)	POCP (kg C_2H_4 eq)	ADPE (kg Sb eq)	ADPF (MJ eq)
Tessuto Notturno	18.6	$1.22x10^{-5}$	$7.39x10^{-2}$	$1.92x10^{-2}$	$3.43x10^{-3}$	$4.91x10^{-5}$	262
Ctd. Grand Pythonss	19.9	$1.23x10^{-5}$	$7.75x10^{-2}$	$1.98x10^{-2}$	$3.68x10^{-3}$	$5.08x10^{-5}$	285
Premiere Must Vitello 85	20.1	$1.23x10^{-5}$	$7.85x10^{-2}$	$2.00x10^{-2}$	$3.71x10^{-3}$	$4.99x10^{-5}$	286

Appendix E: ISO 14044 Critical Review Report

Critical Review of *Life Cycle Assessment of AERA Footwear*, According to ISO 14044

Prepared for:

The Humble Shoe Company, Inc.

Date Completed:
05/28/19

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Table of Contents

1.0 Introduction

This report contains a summary of the critical review, according to the ISO 14044[1] standard, of the report titled *Life Cycle Assessment AERA Footwear,*[2] dated May 28, 2019, completed by Jeremie Hakian. The LCA study was commissioned by the *JBT Corporation* (*JBT*)

The critical review was conducted by an independent life cycle practitioner with no involvement with the execution of the LCA. The critical review assessed the LCA Report for conformance to the ISO 14044:2006 standard and conforms to the ISO 14071:2014 standard[3]. The self-declaration of reviewer independence and competencies has been provided to the relevant parties in a separate document. This critical review is considered an 'external critical review' under ISO 14044. The review includes an assessment of the life cycle inventory (LCI) model and excludes an assessment of individual data sets.

2.0 Summary of Critical Review by LCA Phase

When compared to the requirements of ISO 14044, the LCA report is found to be in conformance with the applicable requirements. The checklist used for the critical review is included as an Appendix.

2.1 Goal and Scope Definition

The goals of the study are clearly defined in the LCA report. The goals include:

1. To assess the potential environmental impacts associated with the manufacture and distribution of the *AERA* footwear following the guidance and requirements of ISO 14044; and,
2. To quantify the carbon footprint of the *AERA* footwear, over the product life cycle, including raw material extraction and processing, product manufacture, packaging, and product distribution, with the goal of offsetting up to 110% of the greenhouse gas emissions from manufacture and distribution of the product.
3. To quantify other potential environmental impacts, in addition to the impact from greenhouse gases, from the manufacture and distribution of the *AERA* footwear, with the goal of offsetting up to 110% of the environmental impacts of the product.

The scope of the study is defined with respect to the product system boundaries, allocation procedures, the assessment methodology utilized, interpretation, assumptions, and data quality requirements. Additionally, the functional unit is defined consistent with the requirements of ISO 14044.

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[1] ISO 14044:2006 Environmental management – Life Cycle Assessment – Requirements and guidelines
[2] DRAFT-RPT_Humble_Holdings_AERA_052019
[3] ISO 14071:2014 Environmental management – Life cycle assessment – Critical review processes and reviewers competencies: Additional requirements and guidelines to ISO 14044:2006.

2.2 Life Cycle Inventory Analysis

The life cycle inventory modeling is discussed and documented in the Study report. Data is mainly sourced from the manufacturing facilities and representative data is taken from commercial LCI databases. The major unit processes and datasets for the product system are documented, including process flow diagrams and brief descriptions of the major unit processes within the product system boundaries. Representative datasets used in the product system model are tabulated.

2.3 Life Cycle Impact Assessment

Life cycle impact assessment (LCIA) is conducted using the TRACI and CML characterization methods. SimaPro software is used for modeling the impact of each stage, aggregated inventory parameters, and the LCIA results for the life cycle stages are clearly reported.

The limitations of the LCIA methods are documented in the LCA report. The method used for the LCA does not represent a comprehensive set of environmental issues but follows the characterization methods selected for the study.

SimaPro software is used for modeling the impact of each stage and the results for the life cycle stages are clearly reported. The assumptions and limitations of the study and assessment method are documented in the Study report.

2.4 Interpretation

The interpretation phase of the study included a contribution analysis consistent with the PCR and ISO standards, as well as a sensitivity analysis. Recommendations consistent with the goal and scope of the study are provided in the LCA study report as required per ISO 14044.

Appendix: Critical Review Checklist

ISO 14044 Critical Review Checklist				
Report Title:	Life Cycle Assessment of AERA Footwear		**Finding Type**	**Acronym**
Date LCA Report Received:	5/28/2019		Verified (Conforms with requirement)	V
Report Author:	Dr. Gerard Mansell, SCS Global Services	**Original (05/24/19)**	111	
		Final (xx/xx/19)		
Reviewer Name:	Jeremie Hakian		Opportunity for improvement	OFI
Reviewer Organization:	SCS Global Services	**Original (05/24/19)**	0	
		Final (xx/xx/xx)		
Date Review Completed:	5/28/2019		Non-conformity with requirement	NCR
Internal Expert?	Yes	**Original (05/24/19)**	0	
		Final (xx/xx/xx)		
External Expert?	No	SHALL CLAUSE	PRACTITIONER	V COMMENT
Review Panel?	No	SHOULD CLAUSE	COMMENT	NCR/OFI COMMENT

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	4: Methodological Framework for LCA			
4.1 General requirements	**General Requirements**			
	→LCA studies shall include the goal and scope definition, inventory analysis, impact assessment and interpretation of results.	V		Goal and scope defined. All relevant LCA phases considered. Study is cradle-to-gate
	→The requirements and recommendations of this International Standard, with the exception of those provisions regarding impact assessment, also apply to life cycle inventory studies.	NA		Not an LCI study.
	→An LCI study alone shall not be used for comparisons intended to be used in comparative assertions intended to be disclosed to the public.	NA		Not an LCI study.
	4.2 Goal and Scope Definition			
4.2.2 Goal of the study	In defining the goal of an LCA, the following items shall be unambiguously stated:			
	The intended application	V		Noted in report
	The reasons for carrying out the study.	V		Noted in report
	The intended audience.	V		Noted in report

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	Whether the results are intended to be used in comparative assertions intended to be disclosed to the public.	V		Noted in report
4.2.3 Scope of the study	In defining the scope of an LCA, the following items shall be considered and described clearly:			
	The product system to be studied.	V		The study evaluates the impacts associated with manufacture of the AERA shoes. Results are based on production in the Veneto region of Italy. Study is cradle-to-gate with distribution.
	The functions of the product systems, or in the case of comparative studies, the systems.	V		The product system is described
	4.2.3.2 The functional unit.			
	→The scope of an LCA shall clearly specify the functions (performance characteristics) of the system being studied.	V		Described in LCA Report.
	→The functional unit shall be clearly defined, measurable and consistent with the goal and scope of the study	V		The declared unit is defined as 1 pair of shoes of a specified mass.
	→The reference flow shall be defined.	V		Defined in Report.
	→Comparisons between systems shall be made on the basis of the same function(s), quantified by the same functional unit (s) in the form of their reference flows.	NA		Not a comparative study
	→If additional functions of any of the systems are not taken into account in the comparison of functional unit these omissions shall be explained and documented.	NA		Not a comparative study
	4.2.3.3 The system boundary.			
	→The selection of the system boundary shall be consistent with the goal of the study.	V		System boundary includes all relevant processes consistent with the study goals.
	→The criteria used in establishing the system boundary shall be identified and explained.	V		Consistent with the ISO requirements
	→Decisions shall be made regarding which unit processes to include in the study, and the level of detail to which these unit processes shall be studied. Reasons and implications of omitting life cycle stages, processes, inputs or outputs must be clearly stated and explained.	V		Described in Report.
	→The deletion of life cycle stages, processes, inputs, or outputs is permitted only if it does not significantly change the overall conclusions of the study	V		All relevant phases included and described. Excluded processes are described.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→ Each of the unit processes should initially describe:			
	(i) Where the unit process begins, in terms of the receipt of raw materials or intermediate products	V		Described in report and summarized in Section 2 and Figure 2.
	(ii) The nature of the transformations and operations that occur as part of the unit process	V		Described in report and summarized in Section 2 and Figure 2.
	(iii) Where the unit process ends, in terms of the destination of the intermediate or final products.	V		Described in report and summarized in Section 2 and Figure 2.
	→The cut-off criteria for initial inclusion of inputs and outputs, the assumptions on which the cut-off criteria are established and its effects on the outcome of the study shall be clearly described and assessed.	V		No known processes or activities contributing more than 1% of the total environmental impact for each indicator are excluded.
	Allocation procedures.	V		Described for primary data consistent with ISO standards; secondary databases referenced as applicable.
	4.2.3.4 LCIA methodology and types of impacts.			
	→The selection of impact categories, category indicators, and characterization models used in the LCIA methodology shall be consistent with the goal and scope of the study and considered as described in 4.4.2.2.	V		Based on ISO requirements. includes requisite impacts using CML and TRACI
	→An LCIA shall be performed using the same methodologies for studies intended to be used in comparative assertions intended to be disclosed to the public. Any differences between these systems regarding these parameters shall be identified and reported.	NA		Not a comparative study.
	Interpretation to be used.	V		Described in report.
	Data requirements.	V		Described in report.
	Assumptions.	V		Described in report.
	Value choices and optional elements.	V		Described in report.
	Limitations.	V		Described in report.
4.2.3 Scope of the study	**4.2.3.6 Data quality requirements shall be specified to enable the goal and scope of the LCA to be met. It should address the following requirements:**			
	→Time-related coverage, geographical coverage, technology coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, uncertainty of information.	V		Data quality requirements of the study are specified.
	Comparative assertions intended to be disclosed to the public must address the above requirements.	NA		Not a comparative study.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→Data quality should be characterized by both quantitative and qualitative aspects as well as by methods used to collect and integrate those data	V		Included in Study Report
	→Data from specific sites or representative averages should be used for those unit processes that contribute the majority of the mass and energy flows in the systems and are considered to have environmentally relevant inputs and outputs.	V		Primary data collection was conducted.
	→The treatment of missing data shall be documented for each unit process and missing location.			
	(i) A "non-zero" data value that is explained	V		Assumed included in LCI databases and software utilized.
	(ii) A "zero" data value that is explained	V		Assumed included in LCI databases and software utilized.
	(iii) A calculated value based on the reported values from unit processes employing a similar technology	V		Assumed included in LCI databases and software utilized.
	4.2.3.8 Critical review considerations in the scope of the study:			
	(i) Whether a critical review is necessary and how to conduct it.	V		Stated in report.
	(ii) Type of critical review.	V		Stated in report.
	(iii) Who would conduct the review and the level of their expertise. If the study is intended to be used for a comparative assertion intended to be disclosed to the public, interested parties shall conduct this evaluation as a critical review.	V		Stated in report.
	Type and format of the report required for the study.	V		Stated in report.
	4.3 Life Cycle Inventory Analysis (LCI)			
Life Cycle Inventory analysis: 4.3.2 Collecting Data	**4.3.2.1 Data Collection**			
	→The qualitative and quantitative data for inclusion in the inventory shall be collected for each unit process that is included in the system boundary.	V		Primary data collected from manufacturer
	→When data have been collected from public sources, the source shall be referenced. For those data that may be significant for the conclusions of the study, details about the relevant data collection process, the time when data have been collected, and further information about data quality indicators shall be referenced.	V		Secondary LCI databases used are referenced.
	4.3.2.2 Measures taken to reach uniform and consistent understanding of the product systems should include:			

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→Drawing unspecific process flow diagrams that outline all the unit processes to be modelled, including their interrelationships;	V		Process flow diagram included in Figure 2
	→Describing each unit process in detail with respect to factors influencing inputs and outputs;	V		Process flow diagram included (Figure 2) with reference to ecoinvent and SimaPro v8.3 software documentation. Descriptions of the major unit processes of the system studied are included as appropriate.
	→Listing of flows and relevant data for operating conditions associated with each unit process;	V		Included process flow diagram and by reference to LCA documentation.
	→Developing a list that specifies the units used;	V		Included with indicator descriptions
	→Describing the data collection and calculation techniques needed for all unit processes to be modelled	V		Data collection procedures described in report. Secondary dataset documented by reference.
	→Providing instructions to document clearly any special cases, irregularities or other items associated with the data provided.	V		None noted
Life Cycle Inventory analysis: 4.3.3 Calculating Data	**4.3.3.1 Data Calculation**			
	→All calculation procedures shall be explicitly documented and all assumptions made shall be clearly stated and explained.	V		Included by reference to LCI databases and software.
	→The same calculation procedures should be consistently applied throughout the study.	V		Consistent methodologies and calculation procedures are assumed implemented in LCI databases and software utilized.
	→When determining elementary flows associated with production, the actual production mix should be used whenever possible.	V		Used wherever data were available.
	→Inputs and outputs related to a combustible material (e.g. oil, gas, or coal) can be transformed into an energy input or output by multiplying them by the relevant heat of combustion.	V		Considered as appropriate within LCI datasets and software. LHV used as appropriate
	4.3.3.2 Validation of data			
	A check on data validity shall be conducted during the process of data collection to confirm and provide evidence that the data quality requirements for the intended application have been fulfilled.	V		Assume conducted as part of data collection.
	4.3.3.3 Relating data to unit process and functional unit			

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→The quantitative input and output data of the unit process shall be calculated in relation to this flow.	V		Assumed included in LCA software.
	→The calculation should result in all system input and output data being referenced to the functional unit.	V		Calculation consistency assumed through use of SimaPro software.
	→The level of aggregation [of inputs and outputs in the product system] shall be consistent with the goal of the study.	V		Relevant processes considered are consistent with study goals and the PCR
	→Data should only be aggregated if they are related to equivalent substances and to similar environmental impacts.	NA		
	If more detailed aggregation rules are required, they should be explained in the goal and scope definition phase of the study or should be left to a subsequent impact assessment phase.	NA		
	4.3.3.4 Refining the system boundary			
	→Reflecting the iterative nature of LCA, decisions regarding the data to be included shall be based on a sensitivity analysis to determine their significance.	V		Sensitivity analyses are included in the study.
	→The initial system boundary shall be revised, as appropriate, in accordance with the cut-off criteria established in the definition of the scope. The results of this refining process and the sensitivity analysis shall be documented.	V		Sensitivity analyses are included in the study.
Life Cycle Inventory analysis: 4..3.4 Allocation	**4.3.4.1 Allocation, General**			
	→The inputs and outputs shall be allocated to the different products according to clearly stated procedures that shall be documented and explained together with the allocation procedure.	V		Documented in report.
	→The sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation.	V		Allocation of primary data described. Secondary data allocation assumed consistent within referenced databases.
	→Whenever several alternative allocation procedures seem applicable, a sensitivity analysis shall be conducted to illustrate the consequences of the departure from the selected approach.	V		Allocation based on physical relationships consistent with the PCR.
	4.3.4.2 Allocation procedure			
	→ The study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below:	V		Described in report.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	Step 1: Wherever possible, allocation should be avoided by 1) dividing the unit process into two or more sub-processes and collecting the input and output data related to these sub-processes; 2) expanding the product system to include the additional functions related to the co-products [...] Step 2: Where allocation cannot be avoided, the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects the underlying physical relationship between them. Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them (i.e. economic).	V		Described in report.
	→ Some outputs may be partly co-products and partly waste. In such cases [...] inputs and outputs shall be allocated to the co-products part only.	NA		
	→Allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration.	V		Described in report and by reference to secondary LCI databases included.
	→The inventory is based on material balances between input and output. Allocation procedures should approximate as much as possible fundamental input/output relationships and characteristics.	V		Assumed considered in secondary databases.
	4.3.4.3 Allocation procedures for reuse and recycling			
	→ Changes in the inherent properties of materials shall be taken into account. For the recovery processes between the original and subsequent product system, the system boundary shall be identified and explained, ensuring that the allocation principles are observed.	NA		
	4.4 Life Cycle Impact Assessment (LCIA)			
Life Cycle Impact Assessment	The LCIA phase shall be coordinated with other phases of the LCA to take into account the following omissions and sources of uncertainty:			
4.4.1. General	→Whether the data quality of the LCI data and results is sufficient to conduct the LCIA in accordance with the study goal and scope definition.	V		Data quality assessment included as per ISO standards.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→Whether the system boundary and data cut-off decisions have been sufficiently reviewed to ensure the availability of LCI results necessary to calculate indicator results for the LCIA.	V		No known processes or activities contributing more than 1% of the total environmental impact for each indicator are excluded.
	→Whether the environmental relevance of the LCIA results is decreased due to the LCI functional unit calculation, system wide averaging, aggregation and allocation.	V		Noted in LCA report.
Life Cycle Impact Assessment 4.4.2. Mandatory Elements of LCIA	**4.4.2.2 Selection of impact categories, category indicators, and characterization models.**			
	4.4.2.2.1 The LCIA phase shall include the following mandatory elements:			
	→Whenever impact categories, category indicators, and characterization models are selected in an LCA, the related information and sources shall be referenced.	V		Included by reference
	→Accurate and descriptive names shall be provided for the impact categories and category indicators.	V		Included in LCA Report
	→The selection of impact categories, category indicators, and characterization models shall be both justified and consistent with the goal and scope of the LCA. It shall reflect a comprehensive set of environmental issues related to the product system being studied.	V		Consistent ISO requirements.
	→The environmental mechanism and characterization model that relate the LCI results to the category indicator and provide a basis for characterization factors shall be described.	V		Summary descriptions provided in report. Details included by reference to TRACI and CML methodologies.
	→The appropriateness of the characterization model used for deriving category indicator in the context of the goal and scope of the study shall be described.	V		Consistent with the ISO requirements.
	→LCI results other than mass and energy flow data included in the LCA (e.g. land use) shall be identified and their relationship to corresponding category indicators shall be determined.	NA		
	4.4.2.2.2 For each impact category, the necessary components of the LCIA include:			
	→Identification of the category endpoint(s), characterization model, characterization factors and definition of the category indicator for given category endpoint.	V		Included by reference to TRACI and CML methodologies.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→Identification of the appropriate LCI results that can be assigned to the impact category, taking into account the chosen category indicator and identified category endpoint(s).	V		Included by reference to TRACI and CML methodologies.
	4.4.2.2.3 In addition to the requirements in 4.4.2.2.1, the following recommendations apply to the selection of impact categories, category indicators, and characterization models:			
	→The impact categories, category indicators, and characterization models should be internationally accepted	V		Based on CML and TRACI consistent with the PCR.
	→The impact categories should represent the aggregated impacts of inputs and outputs of the product system on the category endpoint(s) through the category indicators;	V		Included in CML and TRACI methodologies.
	→Value-choices and assumptions made during the selection of impact categories, category indicators and characterization models should be minimized;	V		Based on CML and TRACI consistent with the PCR.
	→The impact categories, category indicators and characterization models should avoid double counting unless required by the goal and scope definition, for example when the study includes both human health and carcinogenicity;	V		Based on CML and TRACI consistent with the PCR.
	The characterization model for each category indicator should be:			
	→ Scientifically and technically valid, and based upon a distinct identifiable environmental mechanism and reproducible empirical observation; the extent to which the characterization model and the characterization factors are scientifically valid should be identified;	V		The environmental impact category of abiotic depletion is not based on a distinct environmental mechanism.
	→Depending on the environmental mechanism and the goal and scope, spatial and temporal differentiation of the characterization model relating the LCI results to the category indicator should be considered.	V		Spatial and temporal differentiation of the characterization model is not considered in TRACI or CML.
	→The fate and transport of the substances should be part of the characterization model.	V		Fate and transport are not part of the characterization models.
	4.4.2.2.4 The environmental relevance of the category indicator or characterization model should be clearly stated in the following terms:			
	(a)The ability of the category indicator to reflect the consequences of the LCI results on the category endpoint(s), at least qualitatively;	V		Category indicators are mostly potentials, which are not environmentally relevant.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	(b) The addition of environmental data or information to the characterization model with respect to the category endpoint(s), including: the condition of the category endpoint(s); the relative magnitude of the assessed change in the category endpoint(s); the spatial aspects, such as area and scale; the temporal aspects; the reversibility of the environmental mechanism; and the uncertainty of the linkages between the category indicators and category endpoints.	V		Category indicators are mostly potentials, which are not environmentally relevant.
	4.4.2.3 Assignment of LCI results to the selected impact categories (classification).			
	→Assignment of LCI results that are exclusive to one impact category;	V		Included in SimaPro software implementation of CML and TRACI methodologies.
	→Identification of LCI results that relate to more than one impact category, including distinction between parallel mechanisms and assignment to serial mechanisms.	V		Included in SimaPro software implementation of CML and TRACI methodologies.
	4.4.2.4 Calculation of category indicator results (characterization)			
	→The method of calculating indicator results shall be identified and documented, including the value-choices and assumptions made.	V		Documented by reference to SimaPro software implementation of CML and TRACI methodologies.
	No other recommendations or requirements in Section 4.4.2.4.			
	4.4.2.5 Resulting data after characterization			
	No recommendations or requirements in Section 4.4.2.5.			
4.4.3. Optional elements of LCIA	*No requirements in Section 4.4.3.*			
4.4.4. Additional LCIA data quality analysis.	*No recommendations or requirements in Section 4.4.4.*			
4.4.5: LCIA intended to be used in comparative assertions intended to be disclosed to the public	→The comparison shall be conducted category indicator by category indicator.	NA		Not a comparative study for public disclosure.
	→An LCIA shall not provide the sole basis of comparative assertions intended to be disclosed to the public of overall environmental superiority or equivalence, as additional information will be necessary to overcome the inherent limitations of LCIA.	NA		Not a comparative study for public disclosure.
	→Category indicators intended to be used in comparative assertions intended to be disclosed to the public should be internationally accepted.	NA		Not a comparative study for public disclosure.

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	→Weighting shall not be used.	NA		Not a comparative study for public disclosure.
	→An analysis of results for sensitivity and uncertainty shall be conducted for studies intended to be used.	NA		Not a comparative study for public disclosure.
	→Category indicators intended to be used in comparative assertions intended to be disclosed to the public shall, as a minimum, be:			
	(i) Scientifically and technically valid, i.e. using a distinct identifiable environmental mechanism and/or reproducible empirical observation	NA		Not a comparative study for public disclosure.
	(ii) Environmentally relevant, i.e. have sufficiently clear links to the category endpoint(s) including, but not limited to, spatial and temporal characteristics.	NA		Not a comparative study for public disclosure.
	4.5. Life Cycle Interpretation			
Life Cycle Interpretation 4.5.2 Identification of significant issues	→When the results from the LCI and LCIA phases have been found to meet the demands of the goal and scope of the study, the significance of these results shall then be determined.	V		Contribution analyses included.
	→All relevant results available at the time shall be gathered and consolidated for further analysis, including information on data quality.	V		Documented in LCA Report
	→The results of the evaluation should be presented in a manner that gives the commissioner or any other interested party a clear and understandable view of the outcome of the study.	V		Contribution & sensitivity analyses presented and discussed.
	→The evaluation shall be undertaken in accordance with the goal and scope of the study.	V		LCA studied consistent with goal and scope
	→During the evaluation, the use of the following three techniques shall be considered: completeness check, sensitivity check, consistency check.	V		Included in LCA
	→The results of uncertainty analysis and data quality analysis should supplement these checks.	V		
Life Cycle Interpretation 4.5.3. Evaluation.	**4.5.3.2. Completeness check**			
	→ If any relevant information is missing or incomplete, the necessity of such information for satisfying the goal and scope of the LCA shall be considered. This finding and its justification shall be recorded.	V		Assumptions and limitations documented in report

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (05/17/19)	Final Finding (xx/xx/xx)	Comments
	→If any relevant information, considered necessary for determining the significant issues, is missing or incomplete, the preceding phases (LCI, LCIA) should be revisited or, alternatively, the goal and scope definition should be adjusted. If the missing information is considered unnecessary, the reason for this should be recorded.	NA		
	4.5.3.3. Sensitivity check			
	→ The sensitivity check shall include the results of the sensitivity analysis and uncertainty analysis, if performed in the preceding phases (LCI, LCIA).	V		Sensitivity analyses documented in LCA Report.
	→When an LCA is intended to be used in a comparative assertion intended to be disclosed to the public, the evaluation element shall include interpretative statements based on detailed sensitivity analysis.	NA		
	→The inability of a sensitivity check to find significant differences between different studied alternatives does not automatically lead to the conclusion that such differences do not exist. The lack of any significant differences may be the end result of the study.			
	→ In a sensitivity check, consideration shall be given to:			
	(i) The issues predetermined by the goal and scope of the study	V		Assumed considered in sensitivity analyses.
	(ii) The results from all other phases of the study	V		Assumed considered in sensitivity analyses.
	(iii) Expert judgments and previous experiences.	V		Assumed considered in sensitivity analyses.
	4.5.3.4. Consistency check.			
	If relevant to the LCA study the following questions shall be addressed:			
	(a) Are differences in data quality along a product system life cycle and between different product systems consistent with the goal and scope of the study?	V		Assumed considered in study.
	(b) Have regional and/or temporal differences, if any, been consistently applied?	V		Regional-specific data used as appropriate and available.
	(c)Have allocation rules and the system boundary been consistently applied to all product systems?	V		
	(d) Have the elements of the impact assessment been consistently applied?	V		

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Life Cycle Interpretation 4.5.4. Conclusions, limitations, and recommendations	→Conclusions shall be drawn from the study.	V		Conclusions are presented based on indicator results consistent with the goal and scope of the study.
	→Recommendations shall be based on the final conclusions of the study, and shall reflect a logical and reasonable consequence of the conclusions.	V		Recommendations are provided.
	→Whenever appropriate to the goal and scope of the study, specific recommendations to decision-makers should be explained.	V		Recommendations are provided.
	→Recommendations should relate to the intended application.	V		Recommendations are provided.
	5 Reporting			
5.1 Reporting: General requirements and considerations	→The type and format of the report shall be defined in the scope phase of the study.	V		Described in Report
	→The results and conclusions of the LCA shall be completely and accurately reported without bias to the intended audience.	V		Results and conclusions are Included.
	→The results, data, methods, assumptions and limitations shall be transparent and presented in sufficient detail to allow the reader to comprehend the complexities and trade-offs inherent in the LCA.	V		Results, data, methods, assumptions and limitations are included
	→If results of the LCA are communicated to any third party, regardless of the form of communication, then a third-party report shall be prepared and made available (as a reference document) to any third party to whom the communication is made. The following aspects should be considered:			
	(i) LCA Commissioner and practitioner of LCA (internal or external)	V		Included in Report.
	(ii) Date of report requirements of this International Standard	V		Included in Report.
	(iii) Scope of the study (see 5.2c)	V		Included in Report.
	(iv) Life cycle inventory analysis (see 5.2d)	V		Included in Report.
	(v) Life cycle impact assessment (see 5.2e)	V		Included in Report.
	(vi) Life cycle interpretation (see 5.2f)	V		Included in Report.
	(vii) Critical review (see 5.2g)	V		Described in Report.